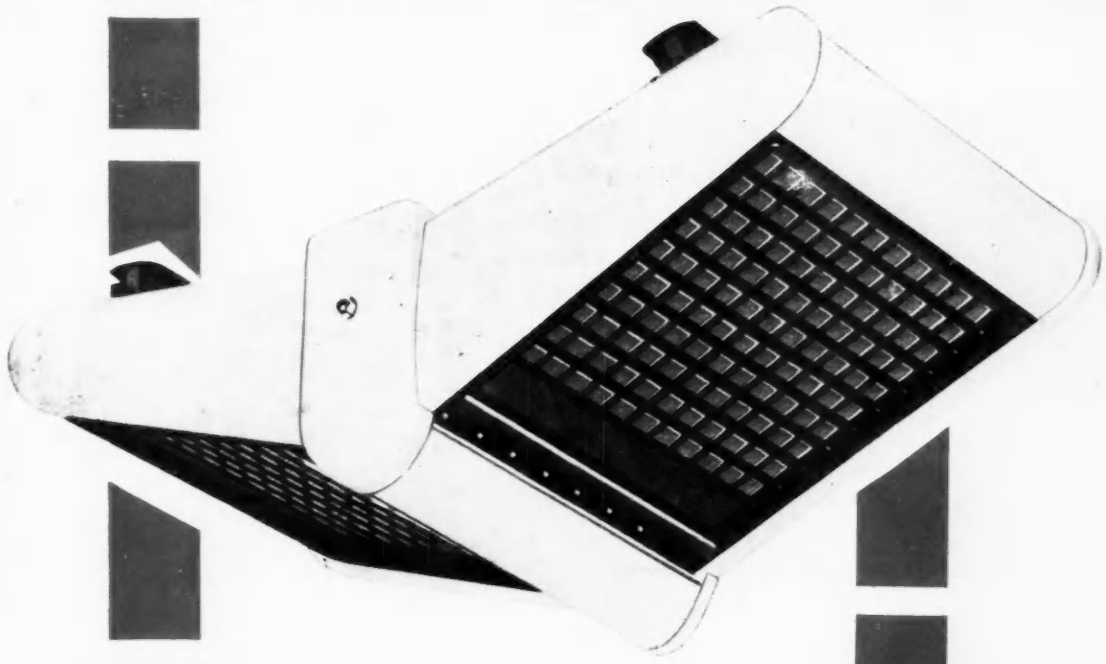
4 JUNE 1958

GAS IN INDUSTRY

Supplement to the "GAS JOURNAL"

Vol. 1 No.2



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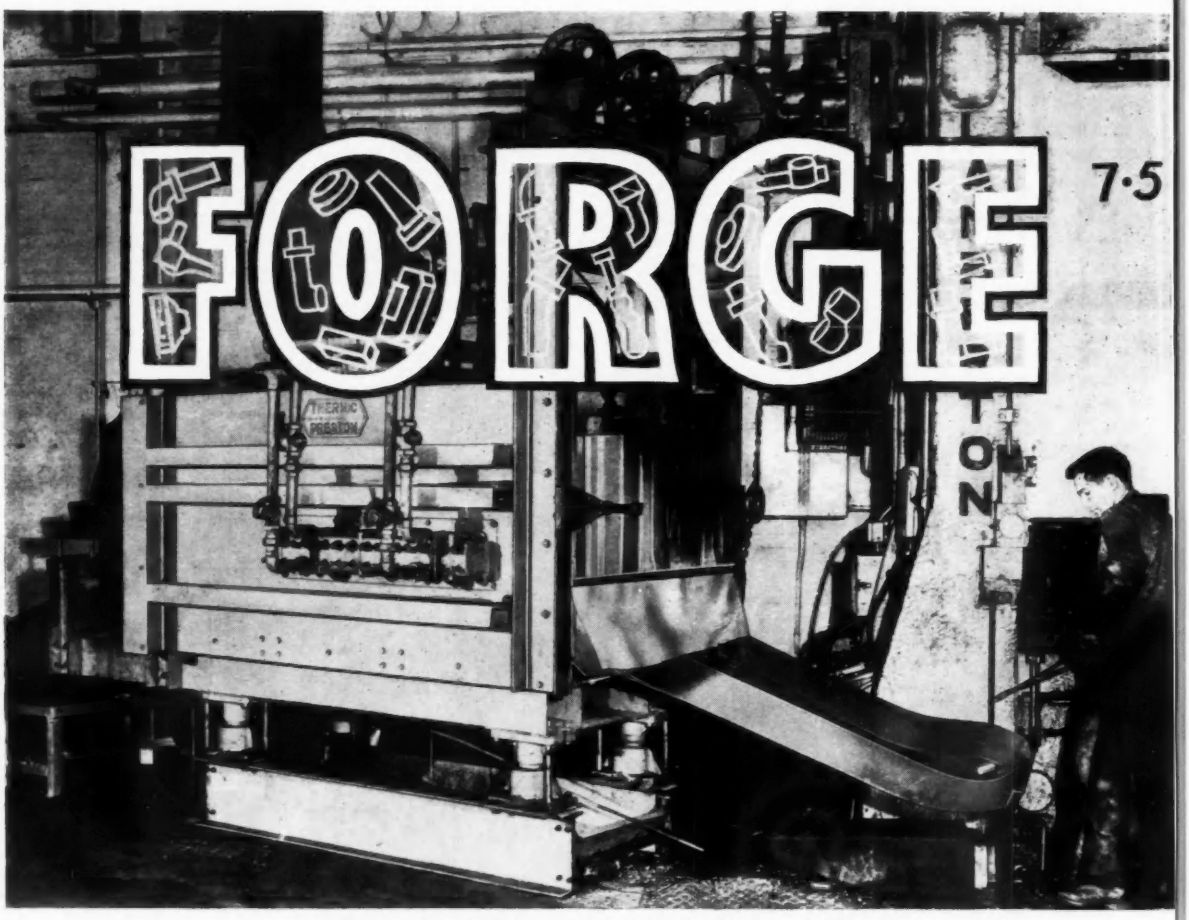

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FURNACES

A wide range of standard or tailor-made mechanised forge furnaces is available, Pusher Type – Rotary Hearth Type – Conveyorised Bar End Heating, with GGC scale-free heating system or fired by Standard Town Gas.
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GAS IN INDUSTRY

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FEATURES

NEWTON, CHAMBERS INTRODUCE COKE-FIRED BOILER FROM THE CONTINENT

OVERHEAD RADIANT HEATING : THE APPROACH TO ASSESSMENT AND INSTALLATION
—By H. Watts

THE TEA-IN-INDUSTRY LOAD

GAS-FIRED FOUNDRY EQUIPMENT STOVES AND HEAT TREATMENT FURNACES

COMBINED DESULPHURISING AND SULPHURIC ACID PLANT

GAS-FIRED STOVING EQUIPMENT
—By E. Martin

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Editorial

Shouting the Odds

MOST industrial gas engineers have some contact with catering matters, particularly in the sphere of works canteens. The exclusive article on bulk tea-making which appears in this issue will, we hope, be of interest and perhaps assistance in this connection. Gas board staffs concerned with commercial cooking must admit that they are to a large extent dependent on the manufacturers, not only in the design of the equipment but also in the way in which it is publicised.

We have been looking at some of the advertisements for gas-fired commercial cooking appliances and one layout has made us reflect on the very important fact that having developed these large-scale catering appliances, we in the gas industry, together with our friends the manufacturers, appear to be loath to publicise the points most likely to appeal to the caterer. We must remember that the initial sowing of the seed that leads to the sale comes from advertising matter, if it is widely read.

We have experienced competition from small capacity deep fat fryers and contact grills, mostly of Continental origin. Combined efforts on the part of some manufacturers and the gas industry have developed appliances in these two markets that in most cases are superior in performance and output to their competitors. To mention just a few, those who visited the Hotel and Catering Exhibition at Olympia last January will have seen grills with branding plates fitted to them. These are effective in grilling food of a wide variety in half the usual time without having to turn the food over, and with half the normal gas.

The saving of gas (which incidentally depends largely on using a smaller grill than is normal) is of far less interest to the chef than the saving in time. This is the great attraction, and when we consider that a 1-in. thick sirloin steak can be cooked in perhaps four to five minutes to a medium rare finish, then indeed we really have something to tell the caterers about, something which is bound to sell a great number of grills. Such information is bound to divert sales that might otherwise go to competitors, back to our own fuel. We must never forget that the great advantage of gas is that it is speedy and flexible, quite apart from the fact that our grills are generally cheaper in initial cost.

Over the past few years there has been a trend towards making the frying pan smaller, particularly for the 'call order' restaurant, and the fact that these pans are smaller in capacity and therefore do not have to heat a great quantity of oil, makes them economical to use Any chef using one of these pans after the vast ranges and fish kettles of the past is bound to appreciate their advantages. In most cases he will be able to cook chipped potatoes from raw in the relatively fast time of 4-4½ minutes, and if he blanches beforehand this will be reduced to only 1-2 minutes. These latter figures are being used by electrical fryers in advertising and are helping to sell large numbers of appliances. But note that our competitors never quote figures from raw chips which, as we all know, is the British Standard Specification for the performance of a gas fryer. When one considers the fact that the cost of these electrical fryers is anything from two to three times that of

equivalent gas fryers, then we must surely accept the fact that advertising *does* pay and what is perhaps more important, whatever the attraction may be we have got to 'shout the odds' about it.

This is not the complete story of our fryers because development is still going on and performances even better than those we have quoted are likely to be achieved within the next 12 months.

Improved Burners

Despite the fact that quite a lot of people seem to be prejudiced in favour of the solid top range as against that of a cooker using open burners, we of course realise that this particular range has completely displaced its solid top counterpart in all the leading kitchens in the country where the staff are trained to the highest degree. This range is going to keep us well and truly abreast of any competition. We know it is good, we know it is fast, we know it is robust, and we know the chef likes it. But even so, we have made the hotplate faster still without adding to the expense—indeed, it is likely to be less expensive and is going to overcome a lot of hotplate maintenance troubles. We refer to the 'Hypact' or similar burner application using the neat flame. It is already tried and proved, but the caterer should know of this; any restauranteur who may be thinking of changing his range, perhaps to a competitive fuel, is going to seek further information before he makes his decision.

Information Wanted

All this information has been published through the technical committees of the gas industry, and those whose interest lies in this direction should know all about it. No doubt sales are promoted on these lines wherever possible, but very often the first we hear of the sale of a competitive appliance is when it is installed. If the necessary information is properly disseminated, these sales can, in almost every case, be diverted to gas. Even at the worst the representative will have a chance to promote his own story.

Now whose place is it to advertise? We appreciate that the gas industry has to be very careful in promoting the sales of one manufacturer against another; therefore it is really up to each manufacturer to give the caterer *all* the information and not just allow it to be read into the advertisement. It should be splashed in headlines. Whenever we read a journal that carries advertising matter we scan through it and as soon as we see a headline that interests us, we stop and read it; it seems reasonable to suppose that caterers do the same. However, we must not just pass the buck to the manufacturer; we have got to talk of these trends in general, we have got to use them ourselves in our own kitchens, and we have got to show all these appliances in our showrooms. It is the only way.

Industrial Appliance Efficiency

THE efficiency of heating appliances is a difficult thing to define simply and concisely. But it is important that any definition should be comprehensive and comprehensible to those for whom a knowledge of this particular property is important. In his paper to the Institution of Gas Engineers this year, which he has called 'Utilisation Efficiency of Industrial Gas Appliances,' Mr. E. A. K. Patrick, officer-in-charge of the industrial laboratory at Watson House, has attempted the solve this difficulty. The generally accepted definition of thermal efficiency is the ratio between the heat transferred to the work and the heat of combustion of the fuel used. Such a definition takes no account of the way the appliance is used on any one occasion or for what purpose it has been specially designed. The design of any appliance must be undertaken by two separate specialists who will be responsible for the process design and the combustion design respectively. The latter will have to provide as much heat as possible from the combustion of the fuel provided, while the former will have to design an appliance which will carry out the particular work expected of it and make use as far as possible of all the heat provided. Sometimes the process designer may be forced by circumstances beyond his control to waste much of this heat. He must also be careful that the appliance is of the right size so that it can be run under the best conditions of working on all occasions, Thus if a heat treatment furnace is being considered, the production capacity of the factory in which it is installed must be such that the furnace is being run at as high a load factor as possible.

Where high temperature heat treatment is carried out, the combustion designer must allow for a sufficiently high temperature gradient to be maintained so that at the high temperatures demanded heat transfer takes place at a reasonable rate. This may make it necessary to increase the amount of energy available at these temperatures, which can be done by preheating the combustion air and the fuel by making use of the heat in the waste gases, and by oxygen enrichment. So much for some of the problems of technical design. But, before a case can be made out for the installation of a new design of furnace, the management of the factory who are very possibly neither fuel technologists nor interested in fuel efficiency as such, must be convinced that production will not suffer, nor will the labour force be adversely affected by its installation. This will become all the clearer when it is realised that the relative value of a product being heat treated may be as much as 100 times the cost of the fuel used in its treatment, and by working a furnace on piece work, the operators may become too exhausted to keep up their rate of production throughout the working day. Under such circumstances the management are likely to be perfectly willing to pay twice the amount for a fuel in a, thermally, less efficient furnace which meets their needs.

Such considerations put a great responsibility on the shoulders of the industrial gas engineer. Not only must he have a very profound knowledge of gas utilisation in all its branches, but also in the design of furnaces and the process being carried out in the factories in which he is hoping to install a gas-fired furnace. These points were brought out in the discussion which followed Mr. Patrick's paper. With an abstract of Mr. Patrick's paper this was fully reported in the Institution Number of the 'GAS JOURNAL' which we published on May 21. A close study of the discussion will provide the reader with an insight into some of the problems involved, for even the best organised factories are likely to have hitches in such things as the transport of articles for heat treatment or, as in the case of a steel works, the failure of scrap to arrive to time at the melting furnaces, with the delay in charging the furnace and its consequent unproductive consumption of fuel. Industrial gas engineers can help the factory managements in the running of their furnaces and advise them to what extent they can be turned down without damaging the refractory linings at week-ends and other slack periods.

Before an operational efficiency of an industrial appliance can be gauged, therefore, all points affecting the actual cost of fuel and its effect on the factory should be calculated.

NEWTON, CHAMBERS INTRODUCE COKE-FIRED BOILER FROM THE CONTINENT

A COKE-FIRED boiler of unique design and exceptionally high thermal efficiency, widely used on the Continent for central heating and hot water supplies in large buildings, is being introduced to this country by Newton, Chambers & Co., Ltd., Thorncliffe, near Sheffield.

It is the Emma boiler—to be known here as the Redfyre Emma—and Newton, Chambers have entered into arrangements with Bronswerk N.V. of Holland for its manufacture and installation in the United Kingdom.

A feature of the design of this boiler is that it incorporates a secondary combustion chamber and is, in effect, a gas producer as well as a boiler.

Consequently, the Emma ensures a thermal efficiency in the 85 to 90% range, achieving a saving of 20-25% in fuel costs when compared with the ordinary type of coke-fired boiler.

Appropiate

On the Continent large numbers of Emma boilers have been installed in the past seven years—in Holland, Germany, France, and Switzerland. These have ranged from a single unit of 250,000 B.t.u. per hour to multiple units of, say, four boilers providing a total output of 30 mill. B.t.u. per hour.

The introduction of the Emma to this country comes at an appropriate time, in view of the new Clean Air Regulations.

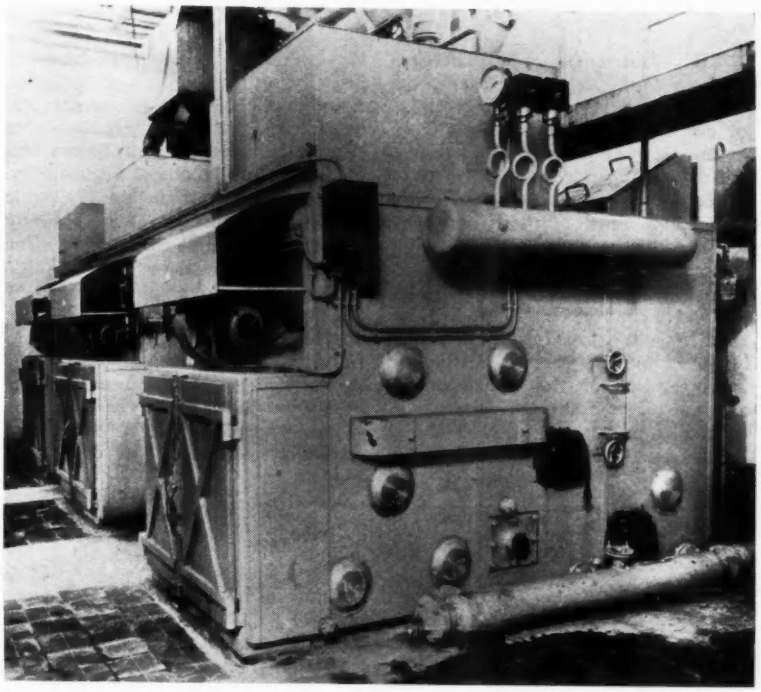
It will also be welcomed because it burns a wide variety of types of coke, including the large size—up to 4 in.—which is in ample supply from gas undertakings.

For use in blocks of offices or flats, schools, hospitals, churches, factories, nursery glass houses and similar buildings it is likely to prove popular, efficient and exceptionally economical in this country.

Temperature Control

The coke for the boiler is stored in a large hopper and is fed by gravity into the fire zone through which primary air is passed horizontally. The gas produced passes into a combustion chamber into which preheated secondary air is admitted, ensuring complete combustion. From there the products of combustion pass through a heat exchanger on their way to the chimney.

Automatic temperature control operates within close limits and the boiler can be raised from low load to full load in a very short time.



An installation of three Emma boilers at a hospital in Holland. Each boiler has a capacity of 1.8 mill. B.t.u. an hour, giving the installation a total capacity of 5.4 mill. B.t.u. an hour.

The mechanical clinkering device is simple in operation, being operated by a lever at the side of the furnace, and the boiler requires little attention. It will operate for eight hours under full load conditions, for 18-20 hours at half load and up to 48 hours on low load conditions without supervision.

The boiler is very compact, takes up little space and can be sited at ground level or in a cellar or can be installed in existing boiler houses.

It can be used with varying types of mechanical coke handling appliances or may be charged manually.

Low Maintenance

Combining the features of unique design, gravity feed and automatic control, the Emma coke boiler has all the advantages of an automatic installation with the highest efficiency and a minimum of maintenance and operation cost.

Stein & Atkinson

Stein & Atkinson Ltd., have decided to cease the manufacture of rotary and end tilting rotary melting furnaces in order to increase their capacity for dealing with their heavy order book for other types of furnaces. The drawings and designs have been acquired by the Monometer Manufacturing Co., Ltd. Stein & Atkinson Ltd., will continue their extensive range of other furnaces, which includes their special lip-axis tilting furnace.

'The Use of Gas in the Ceramic Industry'

In our report of the discussion on the paper 'The Use of Gas in the Ceramic Industry' by Davis and Walker on p. 16 of 'GAS IN INDUSTRY' dated May 7, we quoted Mr. A. C. Jennings, Industrial Gas Officer, West Midlands Gas Board, as saying: '. . . . and I think there is a future for oil in the firing of ceramics.' It is pointed out to us that Mr. Jennings went on to say: 'It is essential that this oil should first be sent to the gasworks and converted into gas when it becomes a suitable fuel for firing pottery.' We regret having omitted these words, thus giving an incorrect meaning to Mr. Jennings' remark.

Overhead Radiant Heating: The

THE effectiveness of any heating system will depend primarily on whether it has been designed to do the job and this paper is intended to assist the enthusiast and to warn the unwary.

It does not matter whether the heating is by radiation or convection or by a combination of these; sufficient heat to overcome the losses must be put into the building, otherwise the system will fall short. This is also true where comfort conditions only, or partial heating, is called for. If the system is not man enough for the job the occupants of the building will complain of cold and the system will be condemned.

Overhead radiant heating as a system is probably abused more than any other. This may be because the installation is relatively simple, resulting in a tendency for those responsible to 'jump' the heat loss calculations and go for quick methods of assessing the number of heaters required. While this may be most useful in obtaining a rough estimate, it can only be done successfully by someone having a wide experience of this method of heating and even then he should, in due course, check his estimate against a full heat loss calculation. There are, several methods of estimating the number of heaters required and some of these, together with considerations on siting heaters, will be dealt with later on, but to begin at the beginning we should consider the fundamentals of heating and heat losses.

In the West Midlands Gas Board's industrial laboratory at Birmingham these 4- and 2-unit Satellite heaters are used.

Why do we need to heat at all? Because generally speaking between October and April the air temperature is not sufficiently high to be comfortable without some form of artificial heating. This is because during that period in the northern hemisphere the sun does not attain a sufficiently high orbit to raise the temperature of that part of the earth's surface. There are, of course other complex factors such as air streams, winds, and cloud layers, which further complicate the issue and give rise to variations in temperatures between comparatively mild to freezing conditions, and any heating system must be flexible enough to cope with these variations.

All this is, of course, clearly understood by most people, but what is not generally appreciated is that the human body is itself capable of giving off heat as well as receiving it. This is explained by the extra clothing we put on during winter in order to insulate the body. During the summer, in spite of lighter clothing, the body perspires in order to lose heat by evaporation.

Since, therefore, the body can both receive and lose heat, one must allow for it in order to maintain comfortable conditions. For instance a person can feel cold in a building maintained at a reasonable air temperature if that person is surrounded by surfaces at a lower temperature, because he will lose heat to those surfaces.

Sunburnt

Conversely a person can feel comfortable at relatively low air temperatures if his bodily heat loss is compensated for by radiant heat. Probably the most convincing example of this is the experience of those who winter in Switzerland, and are comfortable in a swim suit at very low temperatures. Because of the clear atmosphere they receive ample radiant heat from the sun and they return sunburnt. This is an excellent example of overhead radiant heating producing comfort conditions at low air temperatures. In the heating of buildings by radiant heat it is generally accepted that an air temperature of 5°F. lower than is generally called for should be used. Another method is to work to the 'equivalent temperature,' which is the temperature

Approach to Assessment and Installation

By

H. WATTS

A.M.Inst.Gas E.

Appliance Development Manager, Bratt Colbran Ltd.

measured with a black globe thermometer. In effect this amounts to the same thing.

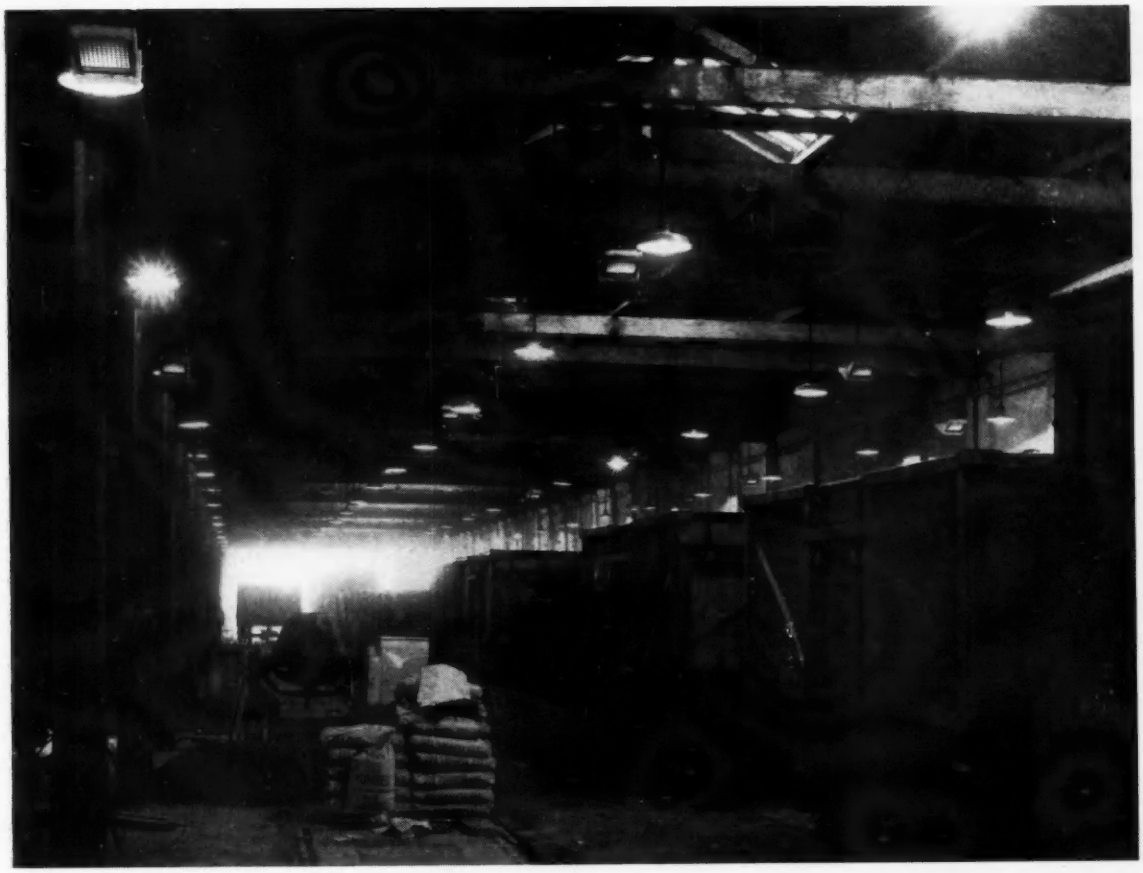
There are three means of heat transfer; convection, conduction and radiation. It is not the intention here to elaborate on methods of heat transfer, let it suffice to say that if a body receives heat by any one of these three means, it will lose heat by all of them to a greater or lesser extent until equilibrium is reached; in other words until the rate at which it is losing heat is equalled by the rate at which it is receiving heat.

Since radiant heat is the method with which we are mainly concerned, we should consider one or two of the most important facts.

First of all radiant heat is an electromagnetic force which travels in straight lines and theoretically has no effect on the medium it travels through. Therefore if a radiant source of 100 B.Th.U. per hour is radiating on to a surface below it, that surface will receive 100 B.Th.U. per hour, provided there is nothing in its path. Any part of the receiving surface that cannot see the source will not receive heat from it. In practice, however, air in a building is not a perfect medium since it will contain moisture and dust particles which will absorb some of the radiation. This incidently accounts for the sun being more effective in Switzerland during the winter than in England, as in the former the air is both dryer and clearer, thus less ultra violet and infra red light are absorbed. With overhead heating by radiation we can ignore this absorption, because the radiant output from overhead heaters is measured under the conditions in which they are used.

Flux Density

The next point is one that we cannot ignore, namely the one that determines the intensity of radiation at floor level, sometimes referred to as flux density. Radiation in many respects follows the same laws as light. One of these is



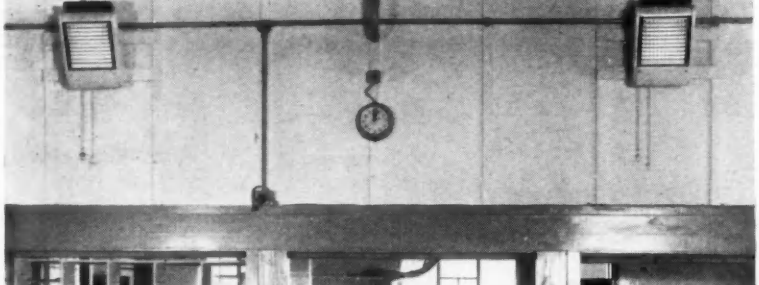
A London Midland Region repair shop, which has 54 Satellite 2-unit overhead space heaters under distant control. This shop is 400 ft. long by 80 ft. wide, by 26 ft. to the ridge; it is open at one end. The heaters are mounted at 13 ft. 6 in.

At St. Mark's Church, Bath, Somerset, 12 Standard and 14 'Junior' Luminous Panel Heaters are mounted. These have mains Comet ignition.

★

This is a picture of a works canteen ideally supplied with 1-unit wall-mounted Satellite heaters.

★



A self-service store at Barrow-in-Furness, G. R. Ackred & Sons, decided to have these Miniature overhead heaters installed for the comfort of their customers.

This paper was read to the technical staff, Sales and Service Departments and Maintenance, Birmingham Division, West Midlands Gas Board.

the inverse square law, which states that the intensity varies as the square of the distance travelled; so that a source of radiation giving a flux density of say, 40 B.Th.U. per hour over an area of 200 sq. ft. at 12 ft. distance will only give 10 B.Th.U. per sq. ft. per hr. at 24 ft. distance, but will be spread over 800 sq. ft. If one doubles the distance travelled the intensity is only a quarter of its original value but is spread over four times the area.

In practice, of course, other factors will operate. For instance, we are never heating a clear open space of unlimited dimensions and normally some of the radiation will fall on the walls and some on machines and benches as well as the occupants. This, of course, in view of what has already been said, is highly desirable since it will assist greatly in the comfort of the occupants by reducing the body losses to cold surfaces.

From the foregoing it may well be asked, 'How is it that the air temperature of a building can be controlled by an air thermostat when the heating is entirely by overhead radiant heaters, if radiation has no effect on the air through which it travels?' The answer is in the statement made that any object receiving heat by one method will lose it by all three. This means that in a building heated entirely by radiation the objects in that building, including the walls, will commence to lose heat to the air in the building the moment they reach a temperature greater than that of the air. This will result in a rise in the air temperature. It may of course be that in some cases it is better to heat the air direct, or use convection heating.

Consideration must now be given to the general question of the heating of buildings.

Transmittance

The fabric, *i.e.*, the walls, floor and roof, will, of course, lose heat by transmittance, that is from the inside surface to the outside. The rate at which the surfaces will lose heat depends on their thickness and the materials of which they are made, as well as the conditions on the outside, or the aspect of the building. This factor is known as the 'coefficient of thermal transmittance' and is usually given the symbol 'U.' Going back to the air inside the building, this having been heated it will rise and pass out of the building through the roof and ventilators, and cold air will enter through open doors, windows, and even to some extent through the walls. The rate at which this takes place will depend on the ventilation rate or the number of air changes per hour. Generally speaking the larger the building the lower becomes the rate of air change, but when calculating the heat losses it will be seen that a suitable allowance is made.

Lastly, there are the factors of time and heat capacity to consider, that is to say, whether the heating is to be intermittent or continuous and whether there is sufficient heat absorbing capacity to retain heat on the one hand or the necessity for a long period of pre-heating on the other.

Insulation

Summing up, the following factors will affect the total heat loss of the building and therefore directly affect the amount of heat needed to meet that loss:—

1. Method of heating, whether radiation or convection or both.
2. Structure.
3. Aspect and orientation.
4. Ventilation rate.
5. Height of building.
6. Period of heating.

Of these six factors item 1 will be considered further, but with regard to the others it is recommended that the Handbook of the Institution of Heating and Ventilating Engineers entitled *The Computation of Heat Requirements for Buildings* is acquired. It is obtainable from the Institution at 75, Eaton Place, London, S.W.1, and goes into considerable detail as well as giving U values for most of the common materials used in buildings. However, it does not deal specifically with overhead radiant heating and should therefore be used with discretion.* The method of heating will be governed largely by the type of building to be heated. If the structure is sound and reasonably well insulated it can be heated to a definite temperature either by warmed air or by radiant heaters. We are not concerned here with the former. If, however, the building is very large or the structure light and the insulation poor, it may not be possible economically to heat the air to a definite temperature level so that one must accept lower air temperatures with radiant heat. Further, if the building is semi-open, such as a loading dock or a wagon repair shed, then it is probably quite impossible to raise the air temperature appreciably and one must depend entirely on radiant effect to give a degree of comfort.

We have therefore three different sets of conditions.

(1) A building that can be fully heated to a definite temperature. This should be 5°F. lower than that called for by pure convection. In these cases the full heat input of the appliances less 10% for the evaporation of water vapour, should be used. Such a building is capable of thermostatic control. The flux density of radiation should be between 15 and 25 B.Th.U. per sq. ft. per hour.

(2) A building where thermostatic control is out of the question but nevertheless a reasonable air temperature can be achieved. Again the whole of the heat output of the appliances is used but the flux density of the radiant heat should be stepped up to compensate for the lower air temperature. This should be between 20 and 30 B.Th.U. per sq. ft. per hour.

(3) The semi-open building where no attempt is made to effect a rise in the air temperature. Radiant heaters are positioned so as to direct radiant heat on to the occupants in order to reduce their bodily heat loss. The flux density under these conditions should not be less than 30 and could be as high as 45/50 B.Th.U. per sq. ft. per hour provided the occupants are not stationary.

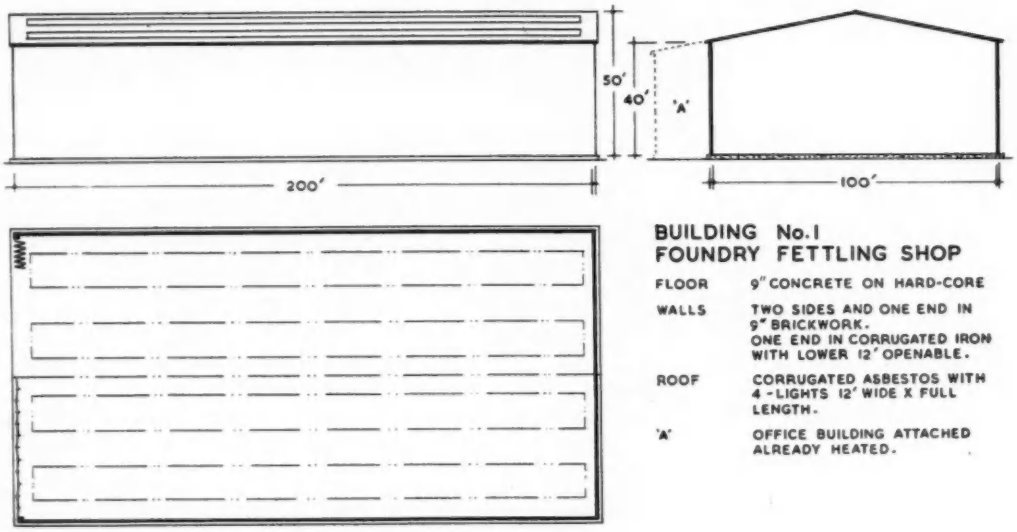
Under categories 1 and 2 the heat losses of the building should be determined and from this figure the number of heaters required decided.

With buildings under category 3 (semi-open), a heat loss determination is meaningless and should not be attempted.

Provisional Estimate

For any given building the question often asked is, 'Can one make a *provisional* estimate of the number of heaters required?' The answer is yes. There are several methods, but these are only rough estimates and do not take the place of the full heat loss calculations. Even people with much experience of overhead heating can

* A new handbook on overhead heating will shortly be issued by Bratt Colbran, Ltd., and this, together with the Institution of Heating and Ventilating Engineers' book, should give most of the information required.



BUILDING No.1
FOUNDRY FETTLING SHOP

FLOOR	9" CONCRETE ON HARD-CORE
WALLS	TWO SIDES AND ONE END IN 9" BRICKWORK. ONE END IN CORRUGATED IRON WITH LOWER 12' OPENABLE.
ROOF	CORRUGATED ASBESTOS WITH 4-LIGHTS 12' WIDE X FULL LENGTH.
'A'	OFFICE BUILDING ATTACHED ALREADY HEATED.

be widely out on occasions when relying only on rough estimates. Three methods are set out below:—

(a) *Floor Area Method*

This method assumes a certain floor coverage for each heater, the figure being assessed for the particular building. It depends therefore on the experience of the user whether he meets the losses or whether, in fact, it is possible to meet the losses. It is probably the most used and yet the weakest method.

(b) *Volume Method*

This method is less liable to underestimation but can give rise to overheating unless adjusted for flux density. The method is to calculate the total volume of the building and then to allow a certain number of B.Th.U. for each cubic foot of space, the figure allowed being between three and seven B.Th.U. per cu. ft., depending on the type of structure.

(c) *The Carpenter's Rule Method*

This is by far the soundest *provisional* method, as it is based on all the heat loss variables, being merely an abbreviation of the full calculation. It assumes that:—

$$H = (0.02\,nC + G + \frac{W}{4})(t - t_o).$$

Plus 10%, plus 20% to 40% dependent on intermittence of heating.

Where H = Total heat loss in B.Th.U. per hour.

0.02 = Specific heat of air B.Th.U. per cu.ft. per °F.

C = Cubic contents of building in cu.ft.

n = Number of air changes per hour.

W = Net area of outside walls in sq. ft.

G = Area of glass, roof and windows.

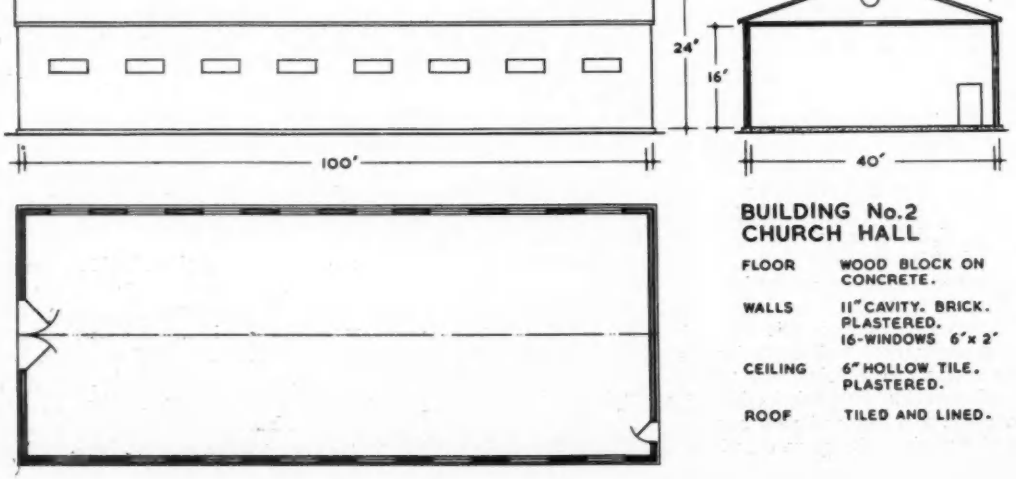
$(t - t_o)$ = Temperature rise required above outside air.

It has one weakness. It fails to take into account sources of high losses such as unlined roofing and corrugated iron end walls, etc. But this method, used in conjunction with a spot check of flux density, can give a very good indication of the heating requirements and need not take many minutes to calculate.

In order to illustrate the point let us consider two dissimilar buildings and compare the three quick assessment methods with the fully calculated heat loss.

Building 1. (See diagram)

An iron foundry fettling shop of light construction having three ex-



BUILDING No.2
CHURCH HALL

FLOOR	WOOD BLOCK ON CONCRETE.
WALLS	11" CAVITY. BRICK. PLASTERED. 16-WINDOWS 6'x 2'
CEILING	6" HOLLOW TILE. PLASTERED.
ROOF	TILED AND LINED.

posed walls, one long and one end in 9 in. brick, the other end being in corrugated iron and openable for locomotives. The second long wall has an office block built on to it, the offices being already heated. The foundry is 200 ft. long by 100 ft. wide; it is 40 ft. high to the eaves and 50 ft. to the ridge with a pitched roof and two lines of 12 ft. wide glass panels in each side. The remainder of the roof is unlined corrugated asbestos. The floor is 9 in. concrete on hard core. Estimated rate of air change is two per hour. It is specified that the foundry be heated to the equivalent of 60°F., i.e., 55°F. actual for ten hours a day, six days a week.

Building 2. (See diagram)

This is a church hall 100 ft. long by 40 ft. wide. It is 16 ft. to the eaves and 24 ft. to the ridge. Walls are 11 in. cavity plastered but exposed on all four sides. Roof is tiled and lined but is also floored over at 16 ft. with 6 in. hollow tiles plastered on the underside. The hall has eight 6 ft. by 2 ft. windows down both long sides. The floor is of wood blocks on concrete. Heating required: equivalent of 65°F. usage: mostly evenings and weekends. Air changes: must allow for three per hour.

Considering the lessons learned from the study of the two buildings chosen, we can say this:—

Building No. 1 is not the type of structure where one would be wise to base an assessment on heat loss, but this loss should, nevertheless, be estimated, as it provides a guide to the order of flux density necessary to produce comfort. From this information one would aim at about 35 to 40 B.Th.U. per sq. ft., per hour which calls for 24 heaters. These would probably be best fitted in three rows of eight heaters per row, the rows being 35 ft. apart with 25 ft. between the heaters mounted at a height of 25 ft.

Calculations—Building 1, Foundry Shop

		U. Value
Area of glass (200 × 12)[4]	= 9,600 sq. ft.	1·0
Area of outer brick wall (9-in.) (200 × 40) + (100 × 45)	= 12,500 sq. ft.	0·47
Area of outer iron wall (unlined) (100 × 45)	= 4,500 sq. ft.	1·2
Area of asbestos roofing (unlined) (200 × 10)[6]	= 12,000 sq. ft.	1·4
Floor area (200 × 100)	= 20,000 sq. ft.	0·2
Cubic capacity (200 × 100 × 45)	= 900,000 cu. ft.	

Allowance for height 10%
Allowance for intermittent heating 30%
Temperature rise required (55—30) .. .. .. = 25°F.

Proposal is to use 4-unit Satellite heaters (output—total 63,000—radiant 31,500 B.Th.U. per hour).

Estimation Method 1. *Floor Area*
Building is light so allow only 1,000 sq. ft. per heater.

$$\text{Therefore, heaters required} = \frac{\text{Floor area}}{\text{Area per heater}} = \frac{20{,}000}{1{,}000} = 20 \text{ HEATERS}$$

Estimation Method 2. *Cubic Capacity*
Building is very large so allow only 3 B.Th.U. per cu. ft. of air space.
Therefore, B.Th.U. required = 900,000 × 3 = 2,700,000.
Total output per heater—90% of input = 90% of 70,000 = 63,000.

$$\text{Therefore, heaters required} = \frac{2{,}700{,}000}{63{,}000} = 43 \text{ HEATERS}$$

Estimation Method 3. *Carpenter's Rule*

$$H = (0{\cdot}02\,nC + G + \frac{W}{4})(t - t_o) + 10\% + 30\%$$

$$= (0{\cdot}02 \times 2 \times 900{,}000 + 9{,}600 + \frac{12{,}500 + 4{,}500}{4})\,25$$

$$= (36{,}000 + 9{,}600 + 4{,}250)\,25$$

$$= 49{,}850 \times 25 = 1{,}246{,}250 \text{ B.Th.U./hr.} + 10\% + 30\%$$

	1,246,250
+ 10%	124,600
	1,390,850
+ 30%	418,200
	1,809,050

$$\text{Therefore, heaters required} = \frac{1{,}809{,}050}{63{,}000} = 29 \text{ HEATERS}$$

Now fully calculating the heat losses

Structure	*Area*		*U.*		*B.Th.U. per hour for 1° F. Rise*
Glass	9,600	×	1·0	=	9,600
9-in. Brick	12,500	×	0·47	=	5,860
Corrugated iron	4,500	×	1·2	=	5,400
Asbestos roof	12,000	×	1·4	=	16,800
Floor	20,000	×	0·2	=	4,000
					41,660

Cub.	*Air change per hour*	*Specific heat*	
Air 900,000 ×	2 ×	0·02	36,000
			77,660
Allowance for height 10% of total			7,760
			85,420
Allowance for intermittent heating 30%			25,600
			111,020

$$\text{Temperature rise required } 25° \text{ F.} = \frac{2{,}780{,}000}{2{,}780{,}000}$$

$$\text{Therefore total number of heaters required} = \frac{2{,}780{,}000}{63{,}000} = 44 \text{ HEATERS}$$

For comparative purposes only consider the flux density. Each heater gives 45% of input as radiant heat, therefore, the flux density per heater over the total floor area of 20,000 sq. ft. will be—

$$\frac{70{,}000 \times 45}{100 \times 20{,}000} = 1{\cdot}575 \text{ B.Th.U. per sq. ft. per hour per heater}$$

Summarising we have—

Method	*Floor area*	*Volume*	*Carpenter's rule*	*Calculated heat losses*
Heaters	20	43	29	44
Flux density	31·5	68	45·6	69·4

It is quite obvious from these figures that it is not possible effectively to meet the heat losses without creating a dangerously high flux density. Of the three quick methods the volumetric method gives the clue to this. The other two methods do not.

Temperature Rise

Calculating the true flux density from the 4-unit Satellite heater distribution diagrams, taking a large number of points over the floor area, the figure obtained is 35.2 B.Th.U. per sq. ft. per hour. A purely mathematical average, obtained by dividing the total radiant output by the total floor area, gives a figure of 37.8 B.Th.U. per sq. ft. per hour. One can assume therefore that 7% of the radiant output is in fact absorbed by the walls. This figure will of course vary with the size of the building and the fixing height of the heaters.

It would probably be sound to expect to obtain a temperature rise of approximately 14°F. This is determined as follows:

Heat input

$$\frac{70{,}000 \times 90 \times 24}{100} = 1{,}510{,}000 \text{ B.Th.U.}$$

Heat loss of building from previous calculation = 111,000 B.Th.U. per 1°F.

Therefore, temperature rise = $\frac{1{,}510{,}000}{111{,}000}$ = approximately 14°F.

The ventilation in the building is purely fortuitous and the heating engineer can have little or no control over it, but due to the large capacity of the building the rate of air change per hour will vary very little from that quoted. There need be no concern over the possibility of condensation.

Building No. 2 is a good example of complete heating. It could and probably should be thermostatically controlled. This demands a complete heat loss calculation. The heaters would be best fitted along the two long walls at 20-ft. centres. If thermostatically controlled the thermostat

should be fitted on one of the end walls and should be shielded against direct radiation.

Ventilation

The problem, if any, in this installation is one of ventilation. Unlike building 1. the capacity is not large comparatively, and the heat losses are being met. Further, the building is being heated only very intermittently; the ventilation rate will therefore probably not be as great as three per hour unless some positive aid to ventilation is installed. The difficult period in an installation such as this is usually after the heaters are turned off and the building is shut up. If the ventilation rate is low the concentration of products of combustion will be fairly high and as the building cools down the water vapour will condense. These conditions can be avoided either by leaving the door and windows open for a period after the heaters are shut off or by ensuring that the required minimum ventilation rate is attained. If, as envisaged, the building is to be used as a place of public entertainment, then it is essential that the required minimum ventilation rate is attained anyway. If necessary openings should be made in the ceiling and the roof space ventilated.

Armed Confidence

In the examples given, two entirely different buildings have been considered and in doing this several problems have been faced and solved but they do not, by any means, cover all contingencies and it would not be practical to do so in a paper such as this. There is only one real guide and that is personal experience. It may sound like sales talk but is not the real answer—'The more overhead heating installations one is responsible for, the more one learns and the greater becomes one's experience'? Thus armed confidence is gained and the more overhead heaters one will install.

Calculations—Building 2, Church Hall

		U. Value
Area of glass (6 × 2 × 16)	= 192 sq. ft.	1·0
Area of outer brick (11-in. cavity) 2(100 × 16) + 2(40 × 20) (−192 for glass)	= 4,600 sq. ft.	0·3
Ceiling area (100 × 40)	= 4,000 sq. ft.	0·25
Floor area (100 × 40)	= 4,000 sq. ft.	0·15
Cubic capacity (100 × 40 × 16)	= 64,000 cu. ft.	
Allowance for height 2%		
Allowance for intermittent heating 40%		
Number of air changes allowed per hour 3		
Temperature rise required (60—30) = 30° F.		

Decision is to use 2-unit wall mounted Satellite heaters.

Estimation Method 1. *Floor Area*

Building is good so allow 700 sq. ft. per heater.

$$\text{Therefore, heaters required} = \frac{\text{Floor area}}{\text{Area per heater}} = \frac{4,000}{700} = 5{\cdot}7$$

Say SIX HEATERS

Estimation Method 2. *Cubic Capacity*

Building is of only moderate size and well constructed so allow 5 B.Th.U. per cu. ft.

Volume 64,000 × 5 = 320,000.

$$\text{Therefore, number of heaters required} = \frac{320,000}{31,500}$$

Say TEN HEATERS

Estimation Method 3. *Carpenter's Rule*

$$H = (0{\cdot}02\,nC + G + \frac{W}{4})(t - t_o) + 10\% + 40\%$$

$$= (0{\cdot}02 \times 3 \times 64,000) + 192 + \frac{4,600}{4})\,30$$

$$= (3,840 + 192 + 1,150) \times 30 + 10\% + 40\%$$

$$= 5,182 \times 30 + 10\% + 30\% = 155,460$$

$$+ 10\% \quad 15,540$$

$$171,000$$

$$+ 40\% \quad 68,400$$

$$239,400$$

$$\text{Therefore, number of heaters required} = \frac{239,400}{31,500} = 7{\cdot}9$$

Say EIGHT HEATERS

Now fully calculating the heat losses

Structure	*Area*		*U.*		*B.Th.U. per hour for 1° F. Rise*	
Glass	192	×	1·0	=	192	
Outer Walls	4,600	×	0·3	=	1,380	
Ceiling	4,000	×	0·25	=	1,000	
Floor	4,000	×	0·15	=	600	
						3,072
Air	*Cub. Changes per hour*		*Specific heat*			
Air 64,000	× 3	×	0·02			3,840
						6,912
Allowance for height, say 2%						138
						7,050
Allowance for intermittent heating 40%						2,820
						9,870

Temperature rise 30° F. therefore heat losses 9,870 × 30 = 296,100

$$\frac{296,100}{31,500} = 9{\cdot}4$$

Say 10 HEATERS

Again for comparison consider the flux density. Each heater will give 32% of radiant heat below the horizontal when fixed at 35° from vertical at height of 12-ft. from floor to base of heater.

$$\text{Radiant heat on floor} = 35,000 \times \frac{32}{100} = 11,200 \text{ B.Th.U.}$$

$$\text{Floor area 4,000, therefore flux density per heater} \frac{11,200}{4,000} = 2{\cdot}8 \text{ B.Th.U. per sq. ft. per hour per heater.}$$

Method	*Floor area*	*Volume*	*Carpenter's rule*	*Calculated heat losses*
Heaters	6	10	8	10
Flux density	16·8	28·0	22·5	28·0

From these figures it will be seen that the floor area method can be quite misleading. Carpenter's rule gives a closer approximation, but as the building is relatively small and full heating is required the volume method gives the correct answer. However, this method relies on experience in estimating the number of B.Th.U. required per cubic foot of air space.

Record Sales by Harris Engineering Ltd.

SALES of Harris heating and air cleaning equipment for the first four months of 1958 were higher than for the same period in any previous year. This was reported to the annual sales conference of Harris Engineering Ltd., by Mr. S. R. Marfleet, Sales Manager, at the Company's main works at Coleraine, Co. Londonderry, last month.

Mr. Marfleet was reviewing the year's working. Area representatives' reports emphasised that the gas cabinet-type heater was becoming increasingly popular for use in schools.

When plans for new developments were discussed special mention was made of the new washable nylon filter for air cleaning.

On the third day, Mr. Vivian George of Market Penetration spoke to the staff on the general principles of representation.

Mr. B. J. Duncan, Field Sales Manager, W. C. Holmes & Co., Ltd., talked on the activities of the W. C. Holmes' Gas Cleaning Division, a special mention being made of equipment produced in addition to the Trion air filter. Mr. R. B. Coomber, who is in charge of the Electronics Division, Harris Engineering, described the new Trion free standing model and other important developments in air filtration. Liaison between the Harris/Holmes organisations formed the main topic of the subsequent discussion.

THE TEA-IN-INDUSTRY LOAD

It's What We Make it, says 'Gastronome'

TODAY the service of tea is an integral part of industrial life. The annual gas consumption throughout the country for this purpose is assessed at some 4 mill. therms, which estimate would cover everything from the small rated burners used for boiling kettles of water in little businesses to urns and more elaborate equipment used in larger workshops, factories and warehouses. So wide is the variety of installations, that it becomes a problem in itself and needs to be understood by the gas representative who may be called upon to assist in an installation and, in any event, will want to know about this important operation and use of gas in his approach to industrial management.

It is with this in mind that this contribution to 'GAS IN INDUSTRY' is concerned.

I suggest that you will want to know something about tea making—the cost of providing such a service and other relative costs; to know of the equipment that is used in bulk tea making and of the variations of circumstances that affect the organisation of it.

Basic Requirements

Basic requirements of good tea making are unvarying and simple and if applied correctly cannot fail to produce good results.

They are:—

(1) Use a good blend of tea, and one that is popular in the locality. Most tea blending companies have a marketing service and will advise quite wisely on the subject if called upon to do so.

(2) Use sufficient tea to the required amount of water. For a general guide it is recommended that 2 oz. of tea be used to brew one gallon.

(3) Use freshly boiled water which has been freshly drawn from the water supply. This means that it is necessary to time the boiling point from cold so that the brew can be made immediately. The time to boil a bulk of water is easily ascertained according to the make, size and capacity of the boiler, and should always be given to the consumer.

(4) Always preheat teapots and storage urns.

The Benham bulk water heaters are installed at the canteen of the Beckton products works, North Thames Gas Board.

(5) Keep the pour of the boiling water as short as possible, by doing this the temperature of the 'boiling water' will be kept at the highest possible point. This means taking the teapot or urn right up to the draw-off cock.

(6) Brewing time depends upon the blend of tea being used, but in general terms it is in the order of four to five minutes. It helps considerably if the brew is agitated or stirred quite vigorously during this period. Service of tea should take place as soon as possible after brewing.

(7) Store the dry tea so that its flavour and strength are conserved. Keep it stored away from strong smelling foods and materials.

(8) Most important, keep all the equipment clean. When it is not in use keep it open to the fresh air to preserve its freshness.

If all these simple requirements are observed the tea will be of consistently good quality. A measure of failure can occur, however and it is because the water boiler is so often blamed that it is well to know some of the more common causes. They are:

Under-boiled water.

This fault can usually be found with bulk water boilers, particularly when thermometers are not fitted. It is, of course, due to the operator not ensuring that the water is really boiling before making the brew. The tea will be flat with tea leaves floating on the top of the liquor.

Over-boiled water.

The result of using over-boiled water, that is water that has come to the boil and then been kept at that temperature for a long period, will be a flat, dull liquor. Timing should ensure that the water comes to the boil at the exact minute that tea making is required.

Storage urns and multipots.

Some tea services use storage urns or multipots. These are insulated urns fitted with draw-off cocks and normally have an infuser fitted inside them. This holds the tea and the water is poured through it. It is important that this infuser be removed after brewing time—4-5 minutes—when full. If this is not done the tea will become strong and 'tanny.'

The complaint of under-boiled water is not likely to arise with the pressure and overflow boilers as these are designed so that water that has not reached boiling point cannot be drawn off. There is a small measure of over-boiled water in some designs but this is negligible and not likely to affect bulk tea making.

Wide Field

It is with the boiling of water for tea making that we are primarily concerned and we have at our command a wide field of boilers that can be recommended to industrial management. They fall within three groups: (1) Bulk water boilers, (2) pressure boilers, and (3) overflow boilers.

(1) *Bulk water boilers*

This group covers the familiar kettle with spout, the ordinary urn, and the more elaborate urn with an integral gas burner, filling gauge glass and thermometer, in fact any container that holds water and can have a burner applied to it. They normally cover a range from kettle capacity to 40 gal. and are to be recommended when the amount of water required and the time to make the tea in bulk are known and are likely to remain unchanged. They are dependent upon the operator in that the time to fill the boiler and to light the burner must be so precise that the contents are at boiling point at a set time for the making of the tea. They are also liable to burning out if

the burner is kept alight and the whole of the water is drawn off. This is in the hands of the operator, but much can be done to help by placing gas controls in an 'easy to handle' position.

(2) *Pressure boilers*

There are several pressure boilers on the market and all of them can be used in bulk tea making for industry.

Some of them hold a store of bulk water and continue to produce boiling water at a rate consistent with brewing time. For example, one popular make will produce 5 gal. from bulk store and then deliver at a rate of 1 gal. per minute for the next 10 minutes, followed by a recovery period of about 5 minutes and then on again at 1 gal. per minute for 10 minutes. This, it will be seen, will cope with a tea demand of 25 gal. over a period of 25 minutes during which 5 by 5 gal. multipots are made and sent out for service. By extending the period the hourly output can be 45 gal. of freshly boiled water, sufficient for 900 cups of tea.

One manufacturer produces a boiler without the bulk reserve but as the output is continuous the requirements are fully met, in that in half an hour 18 gal. of boiling water are produced.

Another class of pressure type boiler is really a bulk boiler and has the advantage of speed, freshly boiled water and automatic in-filling which can only occur after the boiling water has been recovered, so that there is no danger of burning out. The boiler will produce in one continuous discharge 20 gal. of boiling water or sufficient to make 400 cups of tea.

(3) *Overflow boilers*

This group are so called because they function by boiling the water in waterways so that it rises up to a type of weir, this it overflows into a delivery box and then to the draw-off cock. The method ensures that the water is boiling at delivery, and as this type is normally fitted with gas and water controls being interlocked the water ceases to boil when the draw-off is placed in the closed position.

Only the larger capacity boilers in this group are suitable for bulk tea making. From six pints per minute continuous delivery is recommended as the minimum, at this rate a 5 gal. multipot can be filled and the tea brewed in seven minutes. If smaller amounts are required, say, 3 gal., then the 4-pint-per-minute boilers can be recommended.

In general the pressure and overflow boilers should be recommended when they have to work a dual rôle of canteen duty with luncheon and possibly coffee and milk service. For tea break only then all three groups will meet the need, according to requirements.

British Standards Specification No. 2512 controls the requirements of all three groups of boiler and the Gas Council's Approved List of Catering Equipment records those appliances that meet those requirements.

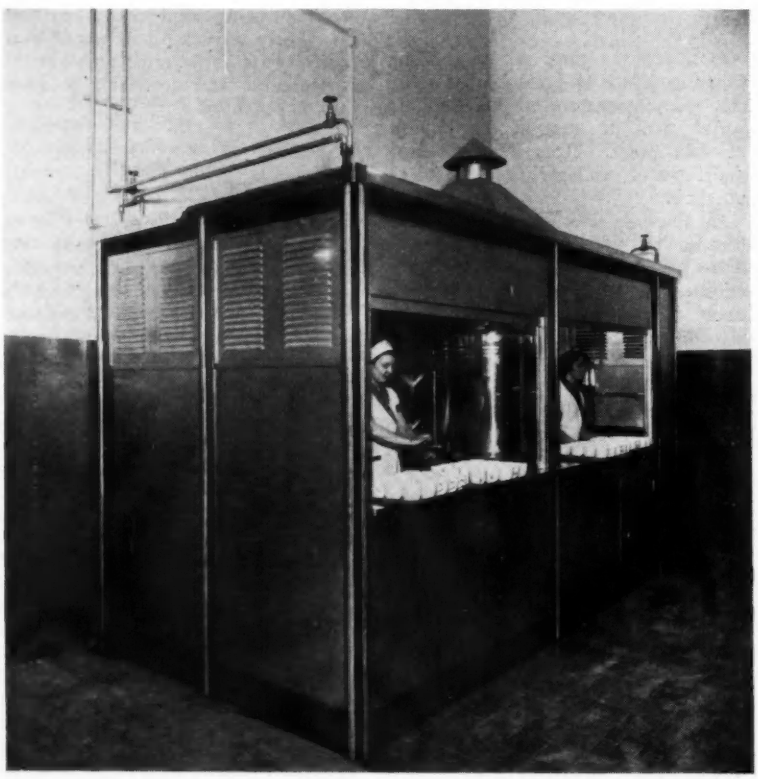
The following manufacturers of boiling water equipment can be recommended; details of their boilers that have been tested to the British Standard Specification are shown in the Gas Council's List.

Aquafont Industries Ltd.
G. F. E. Bartlett & Son Ltd.
Benham & Sons, Ltd.
Hodgkinson & Company.
Hygienic Stove Co., Ltd.
Jackson Boilers, Ltd.
Lumbys Ltd.
Maxol Heaters, Ltd.
Minimax Ltd.
Oliver Tom's Catering Equipment Ltd.
Wm. Still & Sons Ltd.
James Stott & Co., Ltd.
Summerling Ltd.

From the products of all these companies, the answer to any water boiling question is to be found.

The full output capacity and speed in bringing to the boil can only be assured all through the year if scale is removed at intervals and the heat transfer surfaces as well as the burner equipment attended to.

The intervals of servicing will depend on local conditions of water hardness and on the usage of the boiler. Normally the burner and surfaces, cleaning of draw-off cocks and descaling need be carried out every three months in those districts with 'hard' water and possibly less frequently in 'soft' water areas. Much will depend upon the particular groups of boiler and the maker of the boiler.



The tea station at Standard Telephone Cable Co., Ltd., New Southgate. The appliance shown is a Jackson T.5, 25-gal. tea brewer.

False Economy

As with all other gas water heaters it is a false economy to restrict expenditure on servicing this class of equipment. Costly replacements and periods without the use of the boiler can only be the eventual result.

As, during the course of negotiations with industrial management, costs are bound to be an important issue, it is perhaps an advantage to know how the costs of a service of tea are made up. An example is taken for 400

★

Tea making at the Vincent Street canteen of the North Thames Gas Board.

★

people, this being a reasonably average figure.

The equipment to be installed consists of:

1. Water boiler.
2. Water heater.
3. Storage for equipment and ingredients.
4. Storage for milk.
5. Teapots, multipots (storage urns), tea cups and saucers or mugs.
6. Tea trolleys and/or tea trays.

In estimating the size of equipment and subsequently the cost, the basic amounts of ingredients need to be known. Bulk tea making is based on the gallon of liquor and this gallon will supply 20 8-oz. cups or 16 ½-pint mugs.

Ingredients are:—

1 gal. boiling water (small amount is used in preheating teapot).
2 oz. of tea (maximum).
1 pint of fresh milk.
5 oz. of sugar.

Therefore, 400 cups require:—

20 gal. of water.
2½ lb. of tea at 6s. 6d. a lb. = 16s. 3d.
20 pints of milk at 8d. pint = 13s. 4d.
6¼ lb. of sugar at 7d. a lb. = 3s. 8d.

Total for ingredients .. £1 13s. 3d.

Gas costs.

	PENCE
To boil 20 gal. of water in bulk, assuming an average appliance, 68,000 B.t.u. are required, at, say, 24 pence per therm	16.3
To heat water for washing up, either by water heater or boiler used for tea making, 40,000 B.t.u. are required to heat 20 gal. of water to 140°F.	9.6
To running cost of refrigerator at 18,000 B.t.u. per day at 2s. per therm	4.32
Giving a total gas cost of	30.2

(This may be improved upon both in consumption and price in particular cases.)

Boiling water equipment.

	Cost per 400 cups PENCE
Assume a 20 gal. bulk water boiler with burner equipment, thermometer gauge glass at £60 with a life of five years = £12 0s. 0d. per annum and used 500 times (250 days twice a day) ..... =	5.76
Maintenance at £10 0s. 0d. per annum ..... =	4.8

Water heating equipment.

	PENCE
Allowing for a separate water heater at a cost of £18 and a life of five years, this gives £3 12s. per annum = plus maintenance at £1 per annum ..... =	1.4 .48

Storage of equipment can be by cupboard underneath a bench top that would house the water boiler. It would measure approximately 8 ft. by 2 ft. 6 in. by 3 ft. and should be fitted with racks for storage cups, and a separate insulated cupboard for storage of tea and sugar. The fitting in wood and plastic finish would cost £50 and this with a life of five years is £10 ..... = 4.8

Milk Storage

	PENCE
This is by gas refrigerator and a size to accommodate 40 pints of milk a day would be approximately 4 cu.ft. at £63 and with a life of five years = £12 12s. per annum =	6.0
Maintenance would amount to £1 per annum ..... =	.48

Tea cups and saucers.

	PENCE
Four hundred cups and saucers at 2s. a set and replaced entirely once a year—800 at 2s. ..... =	38.4
Tea spoons 400 at 1s. each =	9.6

Teapots.

	PENCE
Twenty at £1 5s. with a life of three years = £8 6s. 8d. per annum ..... =	4.0

Tea trolleys.

	PENCE
Four trolleys at £40 = £160 and with a life of five years = £32 per annum ..... =	15.3

Washing-up sinks.

	PENCE
A 7 ft. sink unit containing two sinks and drainage with cupboard under for storage of cleaning materials at £90 with a life of five years = £18 p.a. ..... =	8.6
To cleaning materials, detergents, etc., etc., say £20 per annum ..... =	9.6

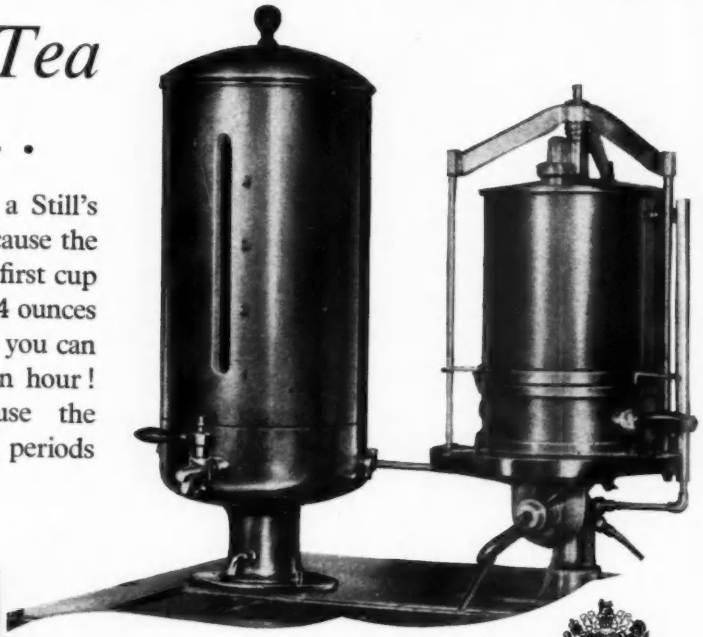
The total costs, not including labour and any charges against accommodation which do not concern us, would amount to:—

	PENCE
Water boiler	5.76
Maintenance	4.8
Water heater	1.4
Maintenance	.48
Storage bench	4.8
Refrigerator	6.0
Maintenance	.48
Tea cups	38.4
Tea spoons	9.6
Tea pots	4.0
Tea trolleys	15.3
Sink unit	8.6
Cleaning materials ..	9.6
Total	109.22
Add gas costs	30.2
Add cost of ingredients £1 13s. 3d. ..... =	399
Cost per cup of tea (400)	1.34

The life of any of the equipment has not been placed higher than five years for the purposes of costing. The refrigerator, water heater and

Make Better Tea at Less Cost . . .

And make it faster! You can with a Still's Tea Brewer. You get better tea because the brew is of uniform consistency from first cup to last. It costs you less because 3-4 ounces of leaf give you 4 gallons of tea; and you can make it at the rate of 16 gallons an hour! There's no wastage either because the brewed tea can be stored for long periods without deterioration.



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boiling water

— UP TO 600 PINTS PER HOUR

The Aquafont Automatic Water Boiler is designed to operate efficiently in hard or soft water districts. The Boiler of heavy gauge copper construction is fitted with a patented safety gas cock and automatic water feed, and is foolproof in operation. Gas is only consumed when boiling water is required. These boilers can be operated by unskilled staff without danger. Manufactured in four sizes to supply 200, 300, 400, or 600 pints of boiling water per hour.

WITH THE Aquafont *AUTOMATIC* WATER BOILERS

The Aquafont Cafe Set is identical in design to the boiler with the addition of earthenware, Pyrex or stainless steel lined side urns, water jacketed from main boiler, or can be independently heated in addition by small auxiliary burner. All units can be supplied for operation by liquid gas.

AQUAFONT INDUSTRIES LTD

35 Kentish Town Road, London, N.W.1

Telephone: GULLIVER 6171 (Private Exchange)

sinks for example have a far longer life.

The purpose of this budget is two-fold from our point of view, in the first place it gives us information to place before managements and secondly it reveals the fact that the part that gas plays in the operation is not only important but at a low cost. The equipment using gas and the cost of gas amounts to only 49 pence or 9% of the total costs, and if labour costs are taken into consideration in pricing the cup of tea the percentage is even lower. The percentage is lower still if canteen facilities are used as in many cases they are.

Capital Costs

We must keep this load and consolidate it to such an extent that it will be ours for years to come. I am of the opinion that at the moment fuel costs are not likely to play a very important part in this effort of consolidation, but emphasis will be on output of boiling water and capital costs of the boiler with ease of maintenance.

This means more thought being given to heat transfer without unduly enlarging the size of the boiler itself and to the ease of servicing without the boiler being out of use for more than three hours at the most. Capital costs of boilers need to be completely reconsidered. The use of chromium plate is largely responsible for the high cost of some boilers. Other finishes and indeed other metals can well be used in boiler construction and design and we in the gas industry can do much to help manufacturers in this respect.

★

S.T.3 bulk tea-maker installed at new canteen at Kilmarnock.

★

Combined Desulphurising and Sulphuric Acid Plant

AFTER ten years of experiments and pilot plant trials, Appleby-Frodingham Steel Company, a branch of the United Steels Companies, Ltd., have developed an entirely new combined desulphurising and sulphuric acid plant which is claimed to incorporate major advances on any existing similar process. The first full-scale plant is now being installed at Appleby-Frodingham and is due for completion by mid-1959.

Statutory Obligation

At most integrated steelworks, a certain proportion of coke oven gas is used to fire the open hearth melting furnaces, the remainder being used in reheating furnaces and soaking pits. This gas contains about 1% of sulphur which, apart from adding to the difficulties of making low sulphur steel, results in considerable quantities of sulphur dioxide being released into the atmosphere. In an integrated works making 1 mill. tons of steel ingots a year the use of the Frodingham desulphurising process enables the sulphur dioxide to be recovered, from which as much as 250 tons of sulphuric acid can be produced each week.

In the case of ordinary gasworks supplying town gas, there is a statutory obligation to reduce the sulphur content of the gas to the equivalent of less than two parts per million by volume of sulphuretted hydrogen, a necessity which entails the provision of costly and extensive purification plant. Even after this is done, however, there remains a residue of organic sulphur which cannot be removed in existing purification equipment, and which causes corrosion in domestic hot water and similar appliances.

The plant developed by Appleby-Frodingham, which consists essentially of a fluidised hot iron oxide absorber and regenerator, is capable of removing both hydrogen sulphide and organic sulphur to very low levels; at the same time, too, it enables the recovery of considerable quantities of sulphuric acid. The heat requirements of the plant are met by the combustion of the absorbed sulphur and, once started up, it is self-sustaining for heat.

A pilot plant has been in successful operation for two years, purifying up to 3 mill. cu.ft. of coke oven gas per day. The full scale plant, when completed, will deal with 32 mill. cu.ft. of gas per day.

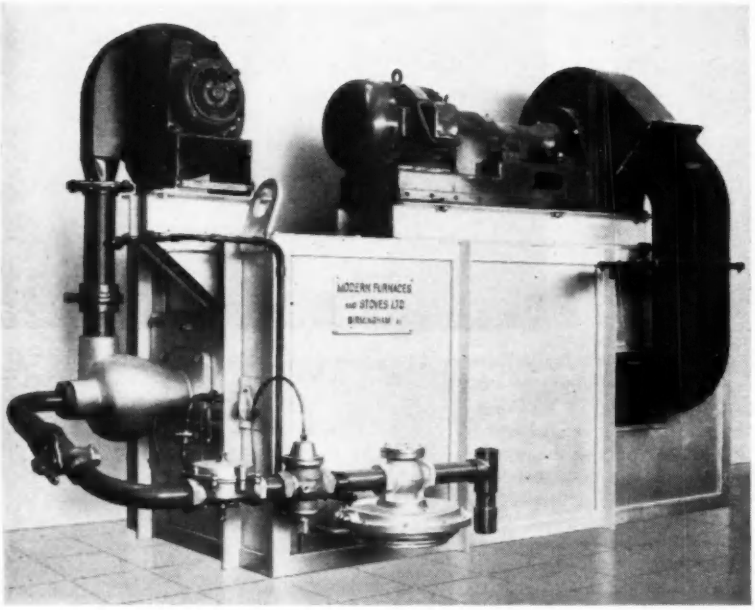
Because the process employs hot gas, it is very much faster than conventional iron oxide boxes or purification towers, while the use of fluidised beds reduces the amount of spent oxide by four-fifths and simplifies its handling and distribution. In compactness and capital cost, the process compares very favourably with existing methods, while the entire operation of the full-scale plant is capable of being handled by two men per shift.

Under the provisions of the Clean Air Act, the height of chimneys discharging sulphur dioxide to atmosphere may be subject to regulation and this, combined with the economic and technical factors already mentioned, suggests that the new Frodingham desulphurisation process is likely to be of particular interest to the steel industry, the gas industry—especially in the case of the larger gasworks—and the chemical and petroleum industries.

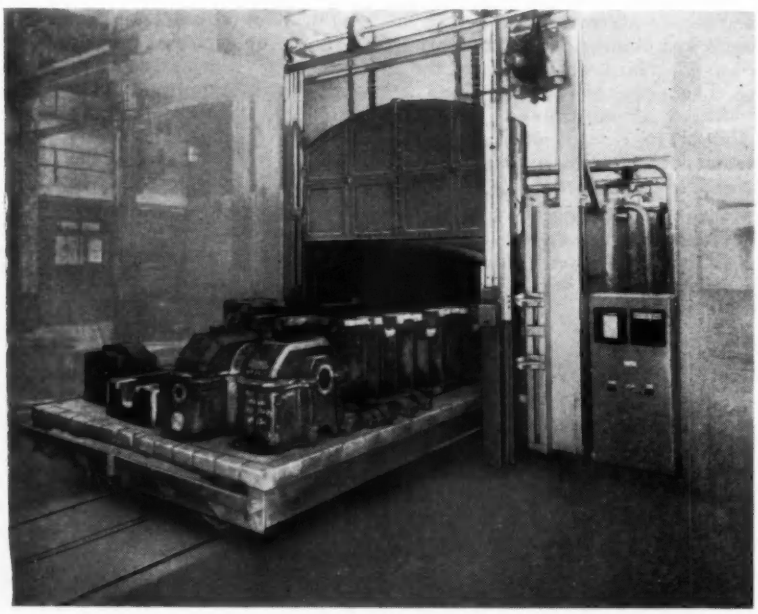
Two Licensees

Appleby - Frodingham have appointed two licensees to build plants based on this process. They are Henry Balfour & Co., Ltd., of Leven, Fife, and W. J. Fraser & Co., Ltd., of Romford, Essex. The unit at present under construction at the Appleby-Frodingham works is being built by W. J. Fraser.

Gas Fired Foundry Equipment, Stoves and Heat Treatment Furnaces



An example of the cross jet gas-fired heating unit.



A gas-fired heat treatment furnace supplied to David Brown Industries Ltd., Huddersfield. It is direct fired and arranged for recirculation. Temperature range 400°-1,100°C.

MANY foundries have turned to gas firing in recent times, partly from reasons of convenience and availability, in addition to the requirements of the Factory Act covering conditions in foundries.

Modern Furnaces & Stoves Ltd., of Birmingham, who are specialists in foundry drying equipment, have developed a self-contained gas-fired heating unit, which incorporates their well-known cross jet recirculation system, for converting existing core and mould drying stoves to gas firing, and have used these units extensively throughout the industry.

Major Safety Factor

The Vortex burners with which these units are fitted have an exceptionally wide range of turn down, and provide a major safety factor in as much as the burner does not go out when operating on thermostatic control, but holds a stable flame at all degrees of turn down. This burner also gives complete combustion and consequently greater efficiency.

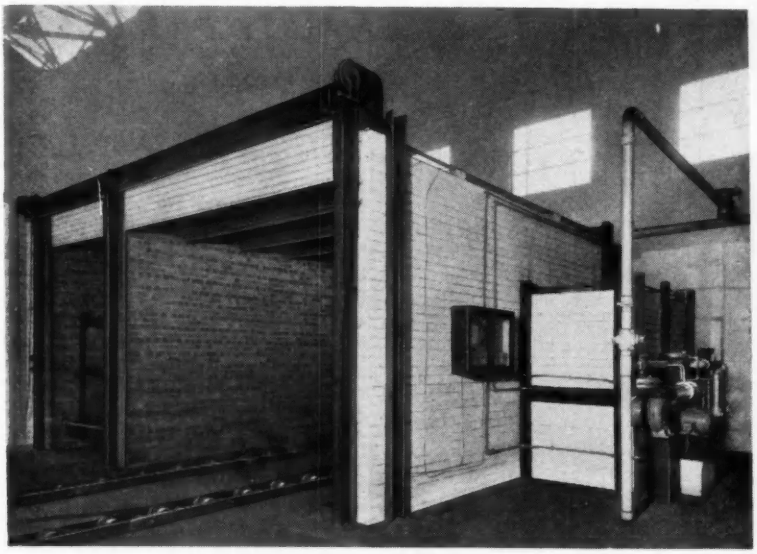
The introduction of the cross jet system goes much farther in improving fuel economy and giving constant drying temperatures, than previous recirculation methods, and has brought the cost of gas firing down to such a degree as to compare well with solid fuel or oil firing, in addition to providing clean and healthy working conditions, with freedom from dust and fumes.

Longer Life

The cross jet system also ensures much longer brick life for the combustion chamber lining by virtue of the fact that the velocity of the recirculating gases draws the products of combustion from the chamber, which avoids excessive heat on the brickwork, and prevents any development of back pressure within the combustion chamber.

Versatility

The versatility of these units is shown by the fact that they are used in iron, steel and non-ferrous foundries, and dry the smallest moulds up to the



Gas-fired core and mould drying stoves at John Hill & Sons (Ironfounders), Ltd., Wolverhampton.

largest ingot moulds made in this country.

Further uses for gas firing in the foundry are in sand drying which is now a necessity owing to the development of the CO_2 process and the adoption of synthetic sands. Here the Newstad rotary sand dryer, with its high efficiency and low operating costs, has an appeal. These machines will completely dry a ton of sand having a moisture content of 5% with only a little over two therms of towns gas.

In foundries where large floor moulds are made, extensive use of portable mould dryers is called for, particularly the Newstad gas-fired portable mould dryer, owing to high efficiency, cleanliness, convenience and absence of atmospheric pollution.

Ladle Dryers

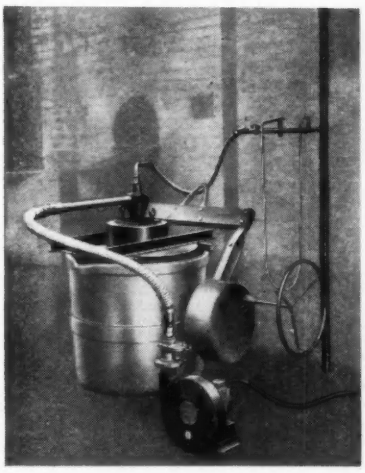
The prohibition of open fires in foundries has provided a field for the use of gas-fired ladle dryers and preheaters and led to the development of the Vortex ladle dryer by Modern Furnaces & Stoves Ltd., and these have proved to be far cheaper in operation than the fires which used to be used for this purpose.

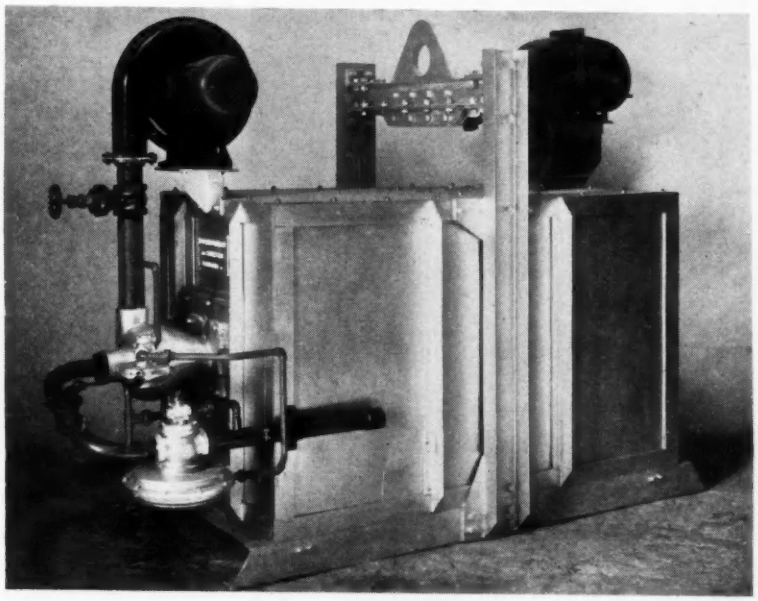
Reduced Fuel Consumption

The use of gas as a medium for firing furnaces used for stress relieving and general heat treatment provides many advantages, and furnaces fitted with Vortex gas burners can produce oxidising or reducing atmospheres as required. In addition, the application of recirculation in the temperature ranges used for tempering and stress relieving substantially reduce fuel consumption whether the orthodox bogie hearth, top loading or 'top hat' type of furnace is used.

Recuperators

Furnaces with direct firing and recirculation are supplied by Modern Furnaces & Stoves Ltd., to cover a temperature range of from 400°-1,100°C., the arrangement of these furnaces can also incorporate recuperators. At temperatures above 650°C., the recirculation system is isolated and the furnace operates in the normal way, the use of the recirculation system when operating in the lower temperature range, in addition to providing constant temperature and quick heat penetration of the load, also prevents flame impingement as the recirculating gases form a screen in front of the burner.





Contrast in dryers: **Above:** *The Vortex gas-fired ladle dryer by Modern Furnaces Ltd.* **Right:** *Gas-fired, high temperature portable mould dryer to raise the mould temperature to 800 C.*

This is one of several supplied to the English Steel Corporation Ltd., Sheffield.

GAS FIRED STOVING EQUIPMENT

MOST industrial finishing processes entail the use of ovens at some stage. The designs available vary considerably according to the process to which they will be applied.

In the majority of ovens, the method of heating used comprises three basic types, namely, natural convection, forced convection, and radiation. It is, however, a physical fact that convection and radiation are virtually inseparable, but one or other will predominate according to how the equipment is designed.

Natural convection is the transfer of heat from a hotter to a cooler body by an intermediary such as air or other gas. When the velocity of the air is artificially increased by the use of a fan, then the transfer of heat is by forced convection. Where the two bodies are in contact neither physically nor by a conducting medium then transfer of heat is by radiation.

Natural convection is, in comparable circumstances, always a slower form of heat transfer than either of the other two.

The types of industrial ovens used fall into two main categories, viz., the static batch type, generally known as box ovens, and the built-in mechanical transportation type, called conveyor ovens.

The former are usually heated by natural or forced convection, and the latter by forced convection or radiation. The fuels used vary from town gas, producer gas, electricity, steam, and oil, but the first named is the most frequently used and is the fuel generally assumed in the following descriptions.

Box ovens are usually applied where the output required is comparatively small or where special processes of long duration are involved. They are normally arranged for loading either by trays, trolleys or suspension rods, the choice of which depends upon the type of product handled, plant layout, etc.

by **E. MARTIN**
A. E. Griffiths (Smethwick) Ltd.

The forms of heating are basically of two types, e.g.—indirect and direct firing. An indirect gas fired air circulated oven of standard design arranged for tray loading, is illustrated in Fig. 1, and shown diagrammatically in Fig. 2.

This is fundamentally a simple treble cased oven in which inner air flow ducts are added to form the stoving chamber. The air in circulation is discharged from a special design of centrifugal fan, mounted on top of the oven, into the air delivery ducts. In the passage through these ducts heat is absorbed from the hot plates forming the gas flow ducts. The air is delivered into the stoving chamber at the bottom and passes vertically up to the top duct, from where it is drawn into the fan for re-circulation.

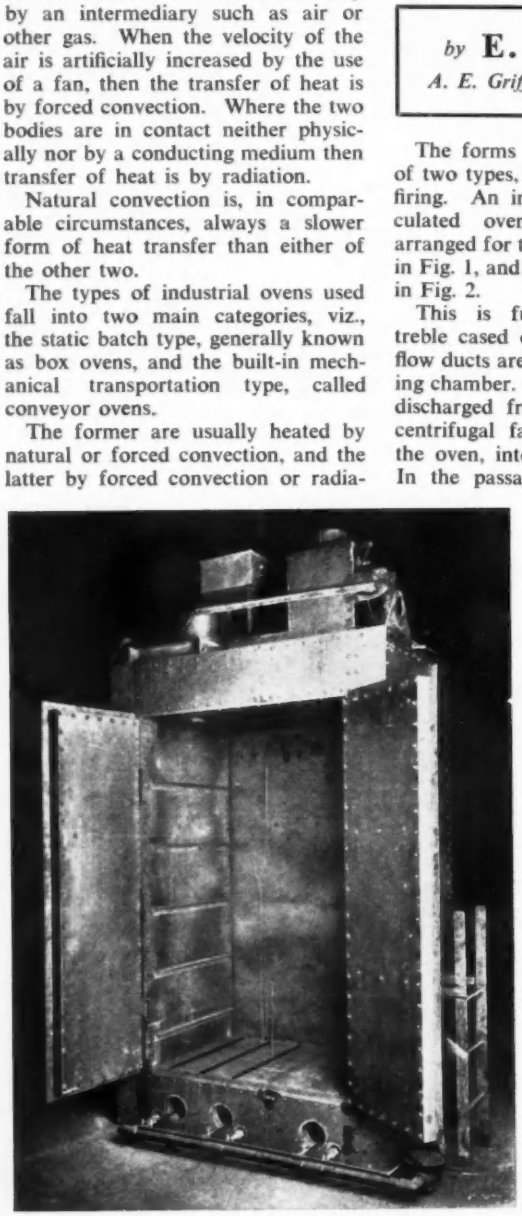
The air is maintained in constant recirculation with a proportion exhausted to atmosphere to remove fumes, volatiles, solvents, etc. An adjustable air inlet is provided and incorporates an oil film type air filter.

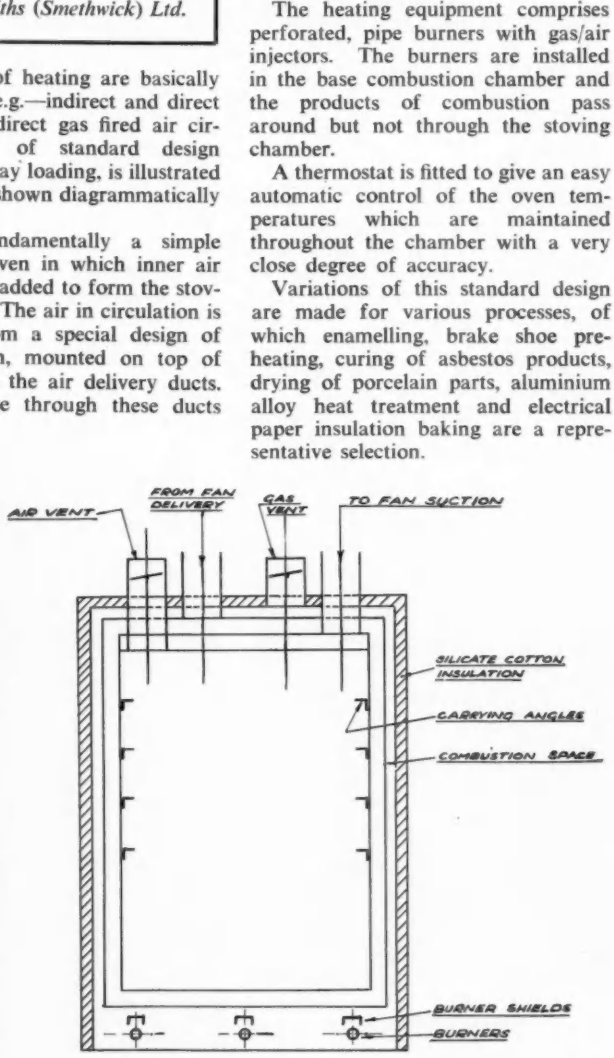
The fumes are exhausted through a ventilator from the stoving chamber. A second ventilator to exhaust the products of combustion is also provided. Both ventilators should be ducted to atmosphere, preferably by independent stacks.

The heating equipment comprises perforated, pipe burners with gas/air injectors. The burners are installed in the base combustion chamber and the products of combustion pass around but not through the stoving chamber.

A thermostat is fitted to give an easy automatic control of the oven temperatures which are maintained throughout the chamber with a very close degree of accuracy.

Variations of this standard design are made for various processes, of which enamelling, brake shoe preheating, curing of asbestos products, drying of porcelain parts, aluminium alloy heat treatment and electrical paper insulation baking are a representative selection.





Left: *Fig. 1. Indirect gas-fired air circulated oven of standard design arranged for tray loading.* **Above:** *Fig. 2. The oven shown diagrammatically.*

A direct gas fired air circulated standard oven, is shown in Fig. 3.

The trolley loading of this oven is so designed that with doors at front and rear of the oven, a semi-continuous stoving operation is possible.

The heating equipment comprises an open flame gas burner unit firing into a brick lined combustion chamber mounted on top of the oven. The mounting of the burner to the front of the combustion chamber is specially designed to facilitate the fitting of combustion safeguard controls which are a recommendation of H.M. Factory Inspectors.

The combustion chamber is connected to a specially designed centrifugal fan from the outlet of which a connection is made to the internal oven air distribution ducts. The fan draws air from the oven and gases from the combustion chamber, and in the process serves as a mixer of the two: The mixture is delivered to the oven and a continuous circulation is set up.

An exhaust ventilator is fitted to the oven to remove solvents, fumes, etc., and an adjustable fresh air inlet is provided. Thermostatic control is a standard fitting. This is a very popular type of oven for stove enamelling all types and colours of paints, except those paints which are particularly susceptible to 'gas checking.' No difficulty whatever is experienced in stoving white gloss enamel, and different colours can be stoved together satisfactorily provided that the paints are of the same properties.

A considerable number of variations of the standard oven are supplied for a wide range of applications.

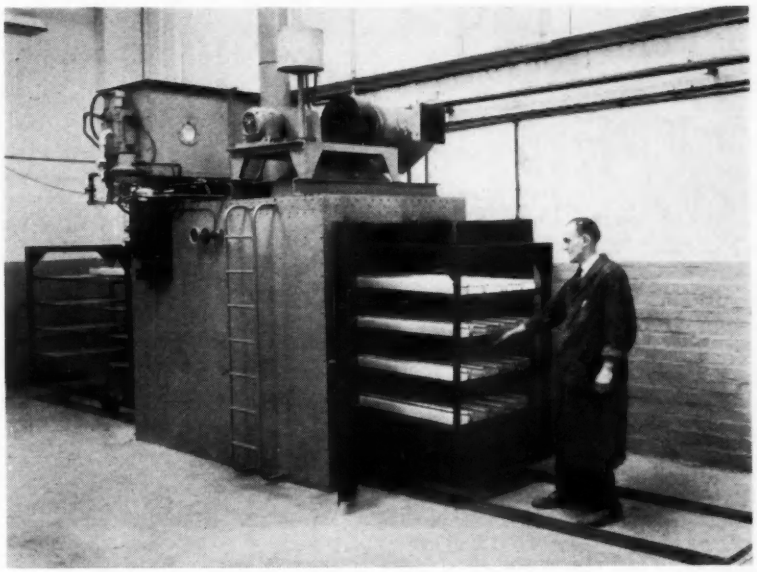


Fig. 3. Direct gas-fired air circulated standard oven.

A forced convection type of stationary oven as described above, together with the many variations of this standard design, offer the user considerable advantages by the provision of uniformity of temperature, faster stoving times, better finishes and fewer rejects.

Conveyor ovens are extremely popular installations for both large and relatively small production output. They are supplied in various designs, but the most usual type is similar to that illustrated in Fig. 4, which is a standard direct gas fired air circulated convection conveyor oven, fitted with enamel circulation and storage facilities.

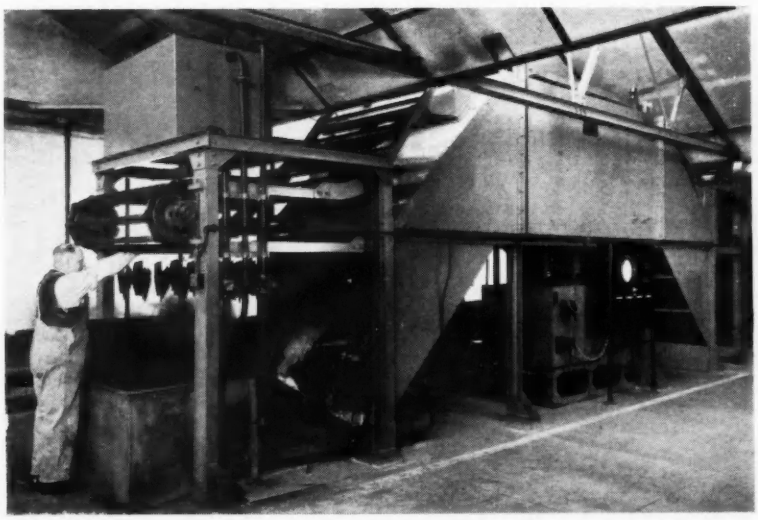


Fig. 4. A standard direct gas-fired air circulated convection conveyor oven, fitted with enamel circulation and storage facilities.

The oven body is an insulated container with sloping ends, incorporating natural heat seals and arranged for work entry and exit through the bottom of the oven.

The length of steelwork at the paint application end is sufficient to provide adequate drainage in the conveyor for dipped work. At the discharge end the extension is such that the stoved work is cooled to permit hand unloading.

Beneath the oven a direct gas fired heating unit is installed which comprises an open flame burner, or burners, firing into the steel cased, brick lined, combustion chamber. The burner mounting is specially designed to facilitate the incorporation of combustion safeguard equipment, now almost invariably fitted for this type of plant.

A typical heater unit is shown in Fig. 5, and also illustrates the control panel.

In conjunction with the heating equipment thermostatic control is provided. The thermostat is immersed into the stoving chamber at such a position that it controls the temperature of the air being discharged from the distribution duct into the oven. With this control it is impossible for the air in circulation through the oven to be a greater temperature than at the control point. Furthermore, a very accurate control is maintained and recorded on a standard design recording thermometer.

The range of temperature is usually 200/500°F. which covers all normal stoving paints. At the rear of the combustion chamber connection is made to a specially designed centrifugal fan which draws air from the oven and products of combustion

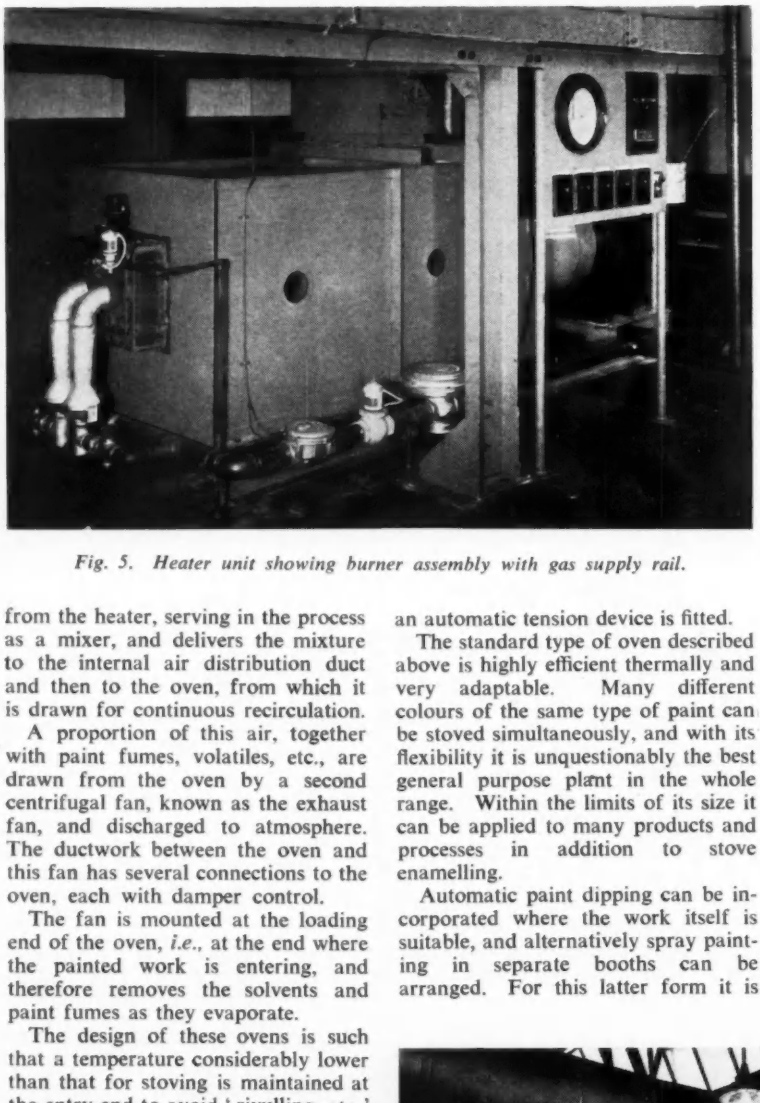


Fig. 5. Heater unit showing burner assembly with gas supply rail.

from the heater, serving in the process as a mixer, and delivers the mixture to the internal air distribution duct and then to the oven, from which it is drawn for continuous recirculation.

A proportion of this air, together with paint fumes, volatiles, etc., are drawn from the oven by a second centrifugal fan, known as the exhaust fan, and discharged to atmosphere. The ductwork between the oven and this fan has several connections to the oven, each with damper control.

The fan is mounted at the loading end of the oven, *i.e.*, at the end where the painted work is entering, and therefore removes the solvents and paint fumes as they evaporate.

The design of these ovens is such that a temperature considerably lower than that for stoving is maintained at the entry end to avoid 'rivulling, *etc.*,' which is caused by the entry of wet work into too high a temperature too quickly.

The conveyor comprises two parallel strands of chain connected together at intervals by tubular carrying bars from which the work is suspended, and the pitch of the bar is selected to suit the work sizes and to avoid contact between work on successive bars. Due allowance is made in this selection of the pitch, for the triangular effect of the inlet and outlet slopes of the oven. The conveyor chains run throughout on angles races and the top return strands are provided with lubrication equipment.

The conveyor is driven from the unloading end, and it is usual to incorporate a variable gear in the drive unit. A safety shear pin device is provided to avoid excessive overloads on the drive. Immediately after the main drive sprockets of the conveyor an automatic tension device is fitted.

The standard type of oven described above is highly efficient thermally and very adaptable. Many different colours of the same type of paint can be stoved simultaneously, and with its flexibility it is unquestionably the best general purpose plant in the whole range. Within the limits of its size it can be applied to many products and processes in addition to stove enamelling.

Automatic paint dipping can be incorporated where the work itself is suitable, and alternatively spray painting in separate booths can be arranged. For this latter form it is possible to provide an entirel different form of conveyor, the monc rail type, which can be arranged t pass through or alongside spra booths and can either be arranged fo direct work suspension or for worl on trays in fixed carriages.

An installation of this latter type i illustrated in Fig. 6. In Fig. 7 a further type is shown and incorporates a table type conveyor in an indirectly heated oven. The indirect gas heating was to the specification of the paint manufacturers.

Each end of this oven is fitted with counterbalanced doors to vary the end openings according to the size of work being processed, which varies from flat cast road signs and street nameplates to fabricated sheet metal traffic bollards. Below the working level of the conveyor a sheet metal housing is fitted to exclude dirt and dust as far as practicable.

Many other variations are possible, but the more usual are those described.

Radiant (infra-red) ovens are, in this country, as a planned oven application, of quite recent origin. An object subjected to radiant heat will increase in temperature at a rate which is determined partly by its surface area/weight ratio and partly by the form of its surface, in addition to which it will be influenced by the composition of the material itself and by any coating applied to that material, and also by the colour and reflective value of that coating.

A very rapid temperature rise is possible, particularly with thinner materials, and this fact also compli-

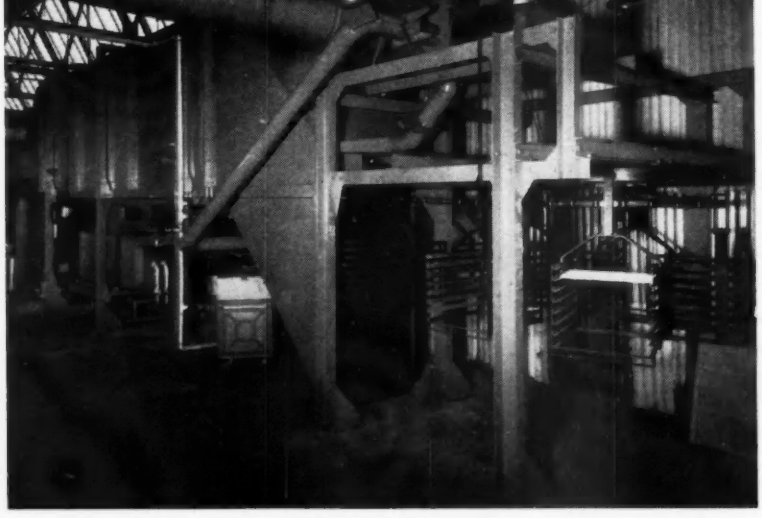


Fig. 6. Standard monorail conveyor oven with fixed carriages.

cates the application of this form of oven (Fig. 8) because the risk of spoilage of the work is very real, and the timing of stoving is critical.

To overcome this difficulty there is a definite tendency on later installations to operate at a very reduced panel temperature and a considerably increased drying time.

The achievement of optimum efficiency with radiant heat ovens is, under normal conditions, comparatively rare because the desirable features of a large production of single articles and the certain continuance of such production are seldom met. Where, however, it is possible to apply radiant heating successfully there are many advantages to be gained. Floor space can be reduced and in many cases the ovens have been installed at overhead level and occupy only such floor space as is necessary to load and unload the conveyor. The form of conveyor most used is the monorail type, from which is suspended the work to be treated. Such conveyors can be arranged to perform many other functions in addition to serving the oven.

Dipping is not usually very satisfactory with radiant equipment, first because of the time required to ensure satisfactory draining, which occupies a very disproportionate length of the conveyor, and secondly, when the wet work enters the oven a secondary drain is precipitated which, when operating with high panel temperature, tends to bake at such speed that the runs and blobs of paint naturally caused in the draining process are dried out in that form. Various other processes in addition to paint drying have been dealt with, including drying arc welding electrodes, drying paper posters after silk screen printing, preheating of coils before wax dipping, drying components after chrome plating, preheating preparatory to soldering, drying blacking on foundry sand cores, etc., etc.

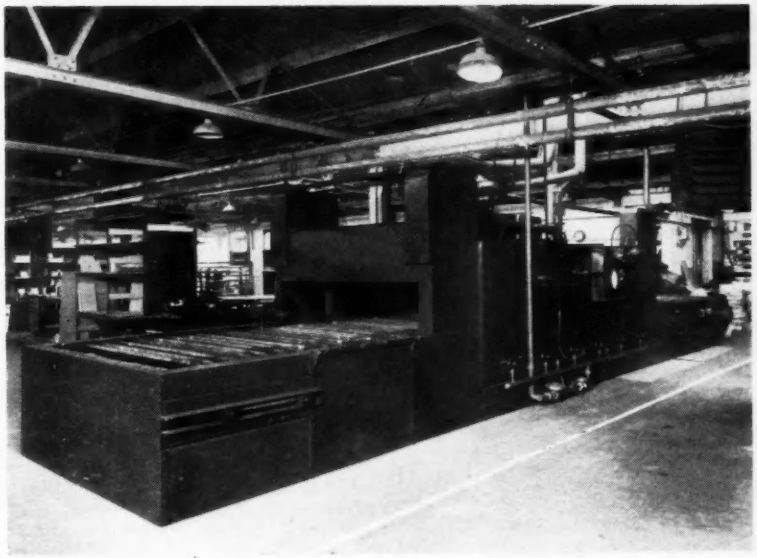


Fig. 7. This type incorporates a table type conveyor in an indirectly heated oven.

Fig. 9 illustrates an oven, suitable for drying blacking on foundry cores, incorporating a slat type table conveyor. This is used for repetition cores and the drying is complete within 12-16 minutes according to the type of core.

It is, however, still necessary to dry these cores in batches of different types, and it is not satisfactory to mix the cores.

The range of possible radiant heat application is therefore very wide and not necessarily easy of selection.

The number of standard types of ovens described, together with the possible variations on each type, cover a very wide field. The choice of which type should be used can only be decided upon in relation to the conditions applicable to the individual user. Space available, products to be treated, process required, treatment before and after stoving, are individual problems which have to be assessed in relation to the final installations, and the answers to these questions are, in the majority of cases, best given by experts specialising in stoving apparatus.

Fig. 8. Radiant (infrared) oven.

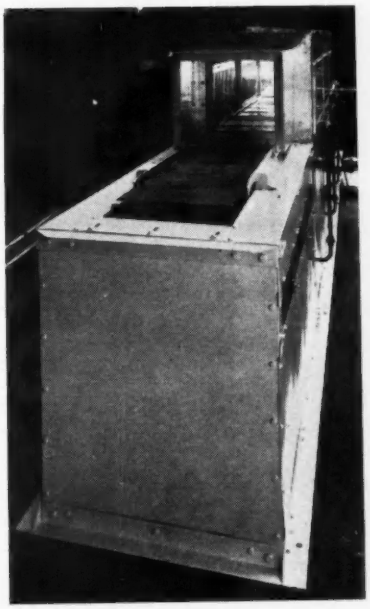


Fig. 9. A radiant heat oven, with a slat type conveyor unit, used for drying blacking on foundry cores.

New High Performance Industrial Gas Meter

THE industrial gas meter undertakes a trojan task in industry. It is the watch dog, acting jointly for the gas board and the board's customers and indeed, its maintained accuracy is a direct measure of the gas industry's goodwill. The industrial meter, as well as being a heavy duty measuring device, must also be sufficiently robust and corrosion-resistant to withstand exposure to heavily polluted atmospheres.

The maintained accuracy of an industrial meter depends largely upon two factors:—

1. The continued freedom from corrosion of the moving parts.
2. The reduction of frictional drag in these moving parts to a minimum.

Willey & Co., Ltd., Exeter (a member of the U.G.I. Group), already well known as manufacturers of industrial gas meters, have, as a result of two years' research, introduced an industrial meter—the 700 S.C.—which is free from maintenance—there is no need for its moving parts to be lubricated periodically by external means.

The valve grids are made from the well tried tin and antimony alloy but the valve covers themselves are made from a special phenolic graphite plastic. As a result their dimensional stability is ensured, they are resistant to water and are both smooth and silent during operation.

All the bearings on the top arms, crank, valve arms and valve covers are made from the plastic material Fluon (Polytetrafluoroethylene) which has a coefficient of friction equivalent to that of ice. This plastic is pressed into a suitable housing and afterwards each bearing is sealed by a paste containing molybdenum disulphide. This provides an ideal lubricant but, it is in addition resistant to oxidation and reaction with all the common solvents and chemicals likely to be encountered in town gas. As a result, the lubricant maintains its lubricating properties over the life of the meter. Finally, the bearings are protected from coarse deposits by stainless steel dust covers.

The other bearings, not mentioned above, are made from stainless steel.

The gearing in the top chamber is protected by a gear-box mounted on the valve plate. This gear-box is made from heavily tinned mild steel mounted on a heavily tinned steel base, the crank and spindles being made from mild steel and stainless steel while the crank bearings are again made from Fluon. The index drive bearings are also made from stainless steel and the box is filled with a non-acid grease.

Diaphragms from East Indian sheep skin are specially selected to be free from faults of fibre structure such as flaying or holes and are cut from solid discs. They are semi-chrome tanned and shaved to thickness on the grain side with all weak flesh layers removed.

The links (top arm, valve and cover arms, etc.) are positive with no adjustable connections so that there is no danger of the parts working loose. As an additional precaution all nuts used in the assembly are self-locking while the valve arm pivots attached to the covers are fitted with a locking device. This is, of course, very important in areas where the meters are opened for inspection or repair by the gas boards.

Although these meters are rated at 700 cu.ft. and 1,200 cu.ft. respectively, they will permit overloading to at least 75% above the capacity shown on the badge without exceeding the normal tolerances. Accuracy is still maintained down to 2 cu.ft. per hour and the meters continue to register the passage of gas at $\frac{1}{8}$ cu.ft. per hour. The stability of the registration of these meters is quite outstanding. Meters tested from 2 cu.ft. per hour to 1,200 cu.ft. per hour show a variation considerably less than 1%; the pressure loss is extremely low, namely, 0.2 in. w.g. at the capacity shown on the badge and an outlet oscillation of only 0.1 in. w.g. achieved.

The 1,200 cu.ft. Super small case industrial gas meter by Willey & Co., Ltd., Exeter.

Self-opacifying Titania Enamels

DEVELOPMENT work over recent years on titania self-opacified cover coat enamels, aimed at raising the coefficient of expansion to around 300×10^{-7} cubical and increasing the fluidity, has resulted in a range of enamels suitable for application to cast iron either direct or on annealing type gripcoats.

Production experience has shown them to be at least as workable as conventional cast iron enamels and chipping or shaling in the field has not proved to be a hazard. This development brings to the field of cast iron enamelling the most up-to-date type of covercoat enamel frits.

Advantages obtained by the user follow closely those conferred by the changeover from antimony-opacified to titania self-opacified enamels on sheet steel some years ago. Satisfactory coverage is obtained in one coat at about 0.010 in. thicknesses compared with 0.015 in.-0.020 in. in other enamels.

This increased covering power has particular advantage on certain cast iron components, *e.g.*, cooker front castings, where due to the relatively complicated shape it is difficult normally to cover radii and corners adequately without building up excessive thickness on adjacent areas; attempts to avoid excessive build up frequently result in poor coverage on radii.

The thinner application makes for greater durability and improved shock resistance, while on recoated work total thickness need not now be excessive; thus reducing the hazards associated with overthick enamels. Control of thickness of application is relatively simple since the enamel is prepared almost exactly like titania sheet iron enamels and is applied using sheet iron spraying equipment. Material savings of about 30% can be achieved with the new enamels.

The quality of enamel finish is improved, particularly in terms of opacity and brightness, and a good quality white is now possible without the use of special undercoats. Pastel colours can also be produced in self-coloured enamels with the same benefits as have been obtained in recent times on sheet steel.

These titania enamels have been developed by Metal Porcelains, Ltd., Cornwall Road, Smethwick, a member of the Vitreous Enamel Development Council, Ltd.